Article

Impacts of COVID-19 Pandemic and Its Lockdown on Global Eating Behavior: A Google Trends Analysis

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Abstract: COVID-19 pandemic and its restrictive measures have present serious unprecedented challenges to human eating behavior. Given that Google Search has become a valuable information resource to examine, predict, and estimate human online interests and behavior, that somehow linked to real people concerns. This study aimed to investigate the features and evaluate the impacts of the COVID-19 pandemic and its lockdown on consumer worldwide interest in eating behavior and its related factors. Google Trends-Relative Search Volumes (RSV) of distinct keywords related to eating behavior, were obtained from a timeframe before and during the COVID-19 pandemic, from January 1, 2018, to December 13, 2020. During the global lockdown from March 11, 2020, to June 30, 2020, RSV curves exhibited a short-term fluctuation of interest in multiple keywords related to eating behavior and its related factors such as food purchasing, food security, food poisoning, panic buying, stocking up, health awareness and mental illness. Spearman's correlation analysis showed a strong correlation between daily confirmed cases and examined keywords. Univariate repeated measures ANOVA following with Bonferroni Post-hoc test revealed that during the year with the presence of COVID-19 pandemic, people worldwide pay more concerns in each keyword (1) environmental and economic factors (unemployment: +269%, food shortage: +180%, food bank: +50%); (2) health- and food-safety concerns (immunity: +138%, vitamin C: +90%, vitamin D: +55%, zinc: +47%, food storage containers: +40%, food packaging: +31%); (3) food choices and interest (local meat: +84%, frozen food: +67%, CSA: +65%, flour: +66%, bread: +53%, soybean oil: +45%, local fruit: +43%, canned tomato: +42%, refrigerated food: +41%, canned meat: +39%, pancake: +37%, cookie: +29%, butter: +29%, canned fish: +29%, liquor: +20%); (4) social and individual factors (take-out: +128%, deliver: +53%), (6) lifestyle factors (stationary bicycle: +110%, dumbbell: +89%, yoga mat: +84%, treadmill: +65%, grocery store: +51%); (6) psychological factors (isolation: +113%). COVID-19 pandemic and its lockdown have had far-reaching effects on global concerns in many factors related to human eating behavior. Swift action is necessarily performed to strengthen the resilience of the food supply chain system, support and adapt to the new normal behavior, and mitigation the profound negative changes, especially targeting those in high-risks and vulnerable groups and food-insecure regions.

Keywords: COVID-19; eating behavior; diet; food concern; Google Trends; health behavior.

1. Introduction

At the beginning of 2020, the world faced the outbreak of 2019 novel coronavirus diseases (COVID-19), which is a highly contagious infectious respiratory disease. It has been spread rapidly nationwide from its epicenter in Wuhan, China, and then to most countries and territories around the globe [1]. On March 11, 2020, the World Health Organization (WHO) declared the rapidly spreading coronavirus outbreak a pandemic and called on member nations to take preparatory and response actions in line with the Global Strategic Preparedness and Response Plan [2]. The expeditious COVID-19's daily increasing confirmed cases and deaths have led to country worldwide to carry out their protective measures by imposing

lockdown, quarantine, as well as travel restrictions in different levels depends on the country's context [3]. Some countries have taken very strict restrictions such as vacation for schools, working from home, nighttime curfew, quarantine for areas with an elevated number of cases, and most importantly, social distancing to minimize the COVID 19 outbreak [4]. The episode of the lockdown period and its duration widely differ by country according to the COVID-19's effects on their public [5]. Nevertheless, the period between March 11, 2020, to June 30, 2020, was considered to be the global lockdown with the confinement were adopted in over 90 countries globally [6]. The fact that COVID-19 pandemic and its preventive measures have led to a great loss of human life worldwide and present serious unprecedented challenges to food security [7–9], food safety [10,11], food supply chains [11,12], drastically alter the purchasing and eating behavior [13–17], lifestyle and physical activities [9,13–16], as well as psychological health [17,18].

Currently, it was estimated that approximately 59 percent of the global population, encompassing 4.66 billion people worldwide have access to the internet, and using online information [19]. The accessibility of the Internet, the use of the search engine, and the rise of social media have considerably affected our social lives, particularly in our concern towards food, dietary, lifestyle, and health-behaviors and even our feeling and emotion [20]. Google Search data is considered a valuable information resource to examine, predict, and estimate human online interests and behavior, that somehow linked to real people concerns, and can be applied in a public health discipline [21]. Google Trends analyzes the popularity or the search volume of queries in Google Search across various regions and languages. Hence, in food and nutrition disciplines, the analyzing data from Google Trend may be useful to predict the global concern of food, dietary, and eating behavior, which may be uniquely suited in the COVID-19 circumstance, to advise COVID-19-related food resource allocation and distribution, and mitigation strategies [22].

The individual eating behavior is a highly personal and multiplex process involving the interplay of various factors that impact one's health and nutrition. These factors can be included as the physical environment, economic factors, individual factors, emotional factors, and social landscape [23,24]. Previous online cross-sectional studies conducted in several developed countries have revealed the changes in habitant's dietary and eating behavior during the COVID-19 confinement period [13–17]. Besides, by analyzing the Google Trends' query volumes, Mayasari et al. have exposed that restricted movement during the first month of COVID-19 pandemic lockdown from March to April 2020, has affected global interest in food security as well as lifestyle behaviors [25]. However, to entity reflect the eating behavior changes, an extensive analysis of a combination of the aforementioned factors should be evaluated (Figure 1). Thus, by analyzing Google Trends' Relative Search Volumes (RSVs) in the three consecutive years from 2018 to 2020, this study aims to evaluate the changes in eating behavior of people worldwide during the year with the existence of the COVID-19 pandemic (January 1, 2020, till December 13, 2020) as well as during its global lockdown imposement (March 11, 2020, to June 30, 2020) and relaxing period (July 1, 2020, afterward). Therefore, the present study will answer the following questions: (1) how did people around the world adapt to the restricted and preventive measures, by changes their concerns related to eating behavior factors during the COVID-19 lockdown period? (2) did these new interests continuously sustain during the confinement easement?, (3) Is there any association between those interests with the number of daily confirmed cases of COVID-19? (4) how did the COVID-19 pandemic generally influence the global people's online interest in the theme of eating behavior throughout the period of existence of COVID-19? The analyses were examined the people worldwide eating behavior's factors in seven related aspects, including environmental and economic factors (e.g. food security, individual economics), health- and food-safety concerns (food safety, immune-boosting nutrients), food choices and preferences (e.g. five essential food groups, canned foods, sugary foods, alcoholic beverages, food types, and food sourcing), social factors (e.g. eating establishment, home-cooking, and food-delivery services), individual factors (e.g. weight concerns), lifestyle factors (e.g. food purchasing, routine physical and leisure activities, private-sports equipment's interests), and psychological aspects (e.g. sleep, emotion, and feeling).
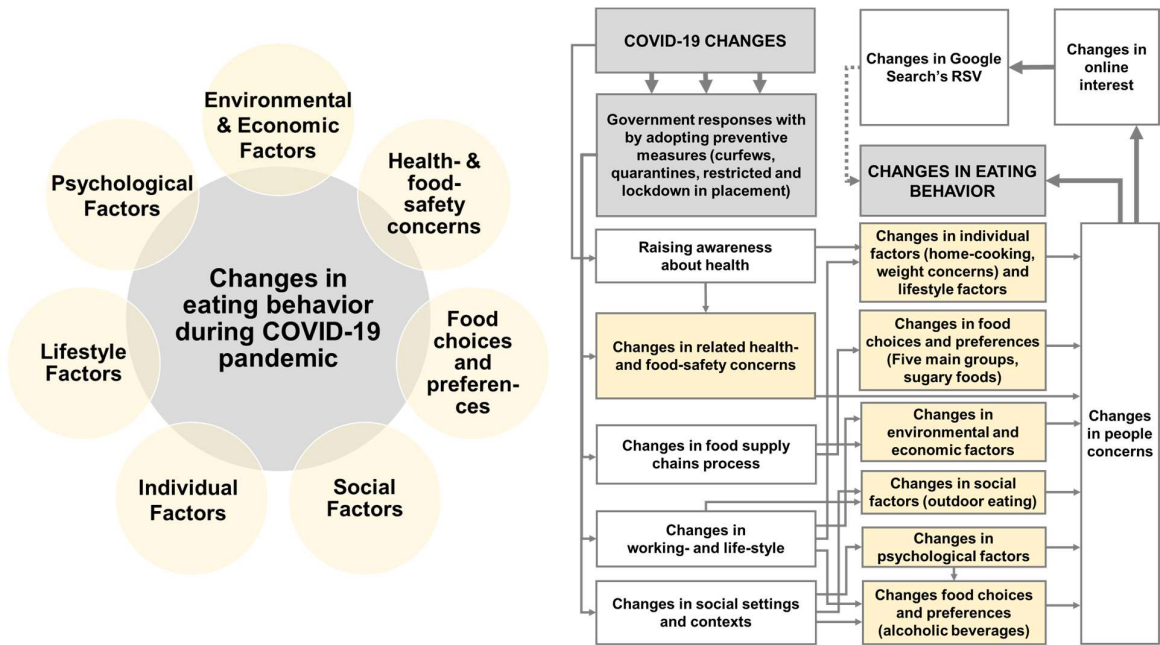
Figure 1. A conceptual framework for the changes in eating behavior during the COVID-19 pandemic was analyzed in the present study. Seven factors contributed to the changes in eating behavior are mentioned as following: (1) environmental and economic factors, (2) health- and food-safety concerns, (3) food choices and preferences, (4) social factors, (5) individual factors, (6) lifestyle factors, and (7) psychological factors.

2. Materials and Methods

2.1. Data Acquisition

COVID-19 Statistic: COVID-19 worldwide data including COVID-19 cumulative confirmed cases and COVID-19 daily confirmed cases between January 1, 2020, till December 13, 2020, were acquired from Our World in Data, Oxford Martin School, University of Oxford, United Kingdom (https://ourworldindata.org/coronavirus)

Google Trend's Coronavirus term: To determine the best term reflect the global online interest in COVID-19, several "keywords" were searched, such as "covid-19", "covid19", "covid 19", "coronavirus", "Sars-cov2", "Sars cov2", "Coronavirus disease 2019" and "Coronavirus". "Coronavirus" was explored as the most popular term global with expressed as the highest RSVs comparing with other terms.

Google Trends' database in Eating Behavior Analysis: Given that Google Search is the most widely used search engine globally, we assumed data towards users' search volume would represent worldwide concerns in eating behavior and its related factors. The global data of Google Search trends were obtained from Google Trends (https://trends.google.com/trends), covering the period from January 1, 2018, to December 13, 2020. Google Search's Relative Search Volumes (RSVs), which indicated the normalized search frequency data (scale of 0 to 100), were delivered by this platform. Each data point represents the related proportion of a distinct search "keyword" or a search "term" of total searches worldwide during the period selected [22]. A maximum of five "keywords" are allowed in the inputting, which enables equivalent comparisons of more than one search term. A value of the RSVs of 100 pinpointed the peak popularity in a given duration and corresponds to the highest popularity if multiple search keys are used, whereas an RSV of <1% indicates no or a very low search volume in a similar given time. To fully analyze the data, we set 0.5 to all RSVs described by Google Trends as <1% and 0.1 to all RSVs equals 0.

2.2. Search terms, categories, and examined duration

The popular and user-specified keywords were applied in searching in Google Trends, which in those keywords that showed a significant trend, which was considered for further selection and analyses. With the aims to compare and determine searches most likely to be related to eating behavior and its related factors in the three segmental periods: before the existence of COVID-19, during the global lockdown period, and after the lockdown lifting, keywords were classified into seven main categories as following: (1) environmental and economic factors (e.g. food security, individual economics), (2) health- and food-safety concerns (food safety, immune-boosting nutrients), (3) food choices and preferences (e.g. five essential food groups, canned foods, sugary foods, alcoholic beverages, food types, and food sourcing), (4) social factors (e.g. eating establishment, home-cooking, and food-delivery services), (5) individual factors (e.g. weight concerns), (6) lifestyle factors (e.g. food purchasing, routine physical activities, leisure activities, private-sports equipment), and (7) psychological aspects (e.g. sleep, emotion, and feeling). Based on the suggestion from Nuti et al., the checklist for documentation of Google Trends searches was applied to improve and ensure the quality and reproducibility of the study (Supplement 1) [22].

As forth mentioned, to compare the eating behavior of people worldwide before the existence of COVID-19, during-, and after-COVID-19 lockdown, as well as the year with the presence of COVID-19 pandemic, we separated the studied period into 6 specified periods: (P1) January 1, 2018, till December 31, 2018 (pre-COVID-19 as reference year 1), (P2) January 1, 2019, till December 31, 2019 (pre-COVID-19 as reference year 2), (P3) January 1, 2020, till December 13, 2020 (the year with the presence of COVID-19 pandemic), (P4) March 11, 2020, till June 30, 2020 (the first global COVID-19 pandemic lockdown), (P5) July 1, 2020, till September 30, 2020 (post first global COVID-19 pandemic lockdown or lockdown easement), (P6) October 1, 2020, till December 13, 2020 (the most updated on the prospective second COVID-19 lockdown in numerous countries).

2.3. Statistical Analysis

All statistical analyses in the present study were conducted using IBM-SPSS Statistic for Windows, v25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including mean and standard error, were computed and presented. Data regarding Google Search's RSVs were examined individually via histograms and then in conjunction via scatterplots. The assumption of the approximate normality of measurements was evaluated by the Kolmogorov-Smirnov test. Spearman's rank correlation coefficients were applied to assess the correlation between RSVs of Google Search's eating behavior and its related factors' terms, and COVID-19 cumulative confirmed cases, COVID-19 daily confirmed cases, and "Coronavirus" RSVs. The strength of the correlation, r, was interpreted as follows: $r \leq 0.2{\sim}0.1$ very weak, $r \geq 0.3{\sim}0.5$ fair, $r \geq 0.6{\sim}0.7$ moderate, $r \geq 0.8{\sim}0.9$ very strong, and $r = 1$ perfect [26]. To compare the differences of RSVs of eating behavior and its related factors between the year without having COVID-19, and the year with the presence of COVID-19 pandemic. The univariate repeated measures analysis of variance (ANOVA) with Greenhouse-Geisser correction was applied following with Bonferroni post-hoc test. A global heat map was built using MapChart (https://mapchart.net/) with the percentage of searches by countries (exclude low search volume regions).

3. Results

3.1. Environmental and individual economic factors

RSVs of search terms related to the environmental factors, particularly in food security, such as "food security", "food shortage", "food bank", "free meal", and "free food" was steadfast during the pre-COVID-19 (Figure 2A). When the global pandemic was announced by WHO, the steep escalation of RSVs curves was observed, and continuously increased during the first global lockdown. The clearest changes were reported in the keywords "food security", "food bank" and "free food". The worldwide heatmap of these

keywords was further explored, which indicated that developed countries like the United States of America (USA), Canada, and United Kingdom (UK) were more likely to search for "food bank", whereas Pacific and Southeast Asian (e.g., Australia, New Zealand (NZ), Malaysia, Indonesia, Philippines) and some African countries for "free food". In the meantime, Pacific Islanders, India, South, and Central Africa nations were more seemingly to seek "food security" (Figure 2C). During the post-lockdown period, these volumes were promptly recoiled to the pre-pandemic stage and were more likely to re-escalate during the second quarantine starting from November 2020.

Concerning individual economic, five keywords related to the job, price, and tax were further explored (Figure 2B). During the first quarter of 2020, RSVs volumes for "job" were similar to those average figures in previous referenced years. Nevertheless, this trend dramatically dropped during the COVID-19 lockdown period, gradually returned during post-lockdown, but were more possibly to re-reduce during the second lockdown. Interestingly, "price" was dramatically declined during the beginning phase of the first lockdown, then sharply spiked and enjoyed high search interest during the pandemic. In the contrast, "unemployment" and "money" relevantly increased during the confinement period and chronologically decreased during lockdown easement. Notably, "unemployment" was still kept at a high range compared with the previous years. Moreover, "tax" was less likely to get attention from people around the world even during the yearly fiscal period.
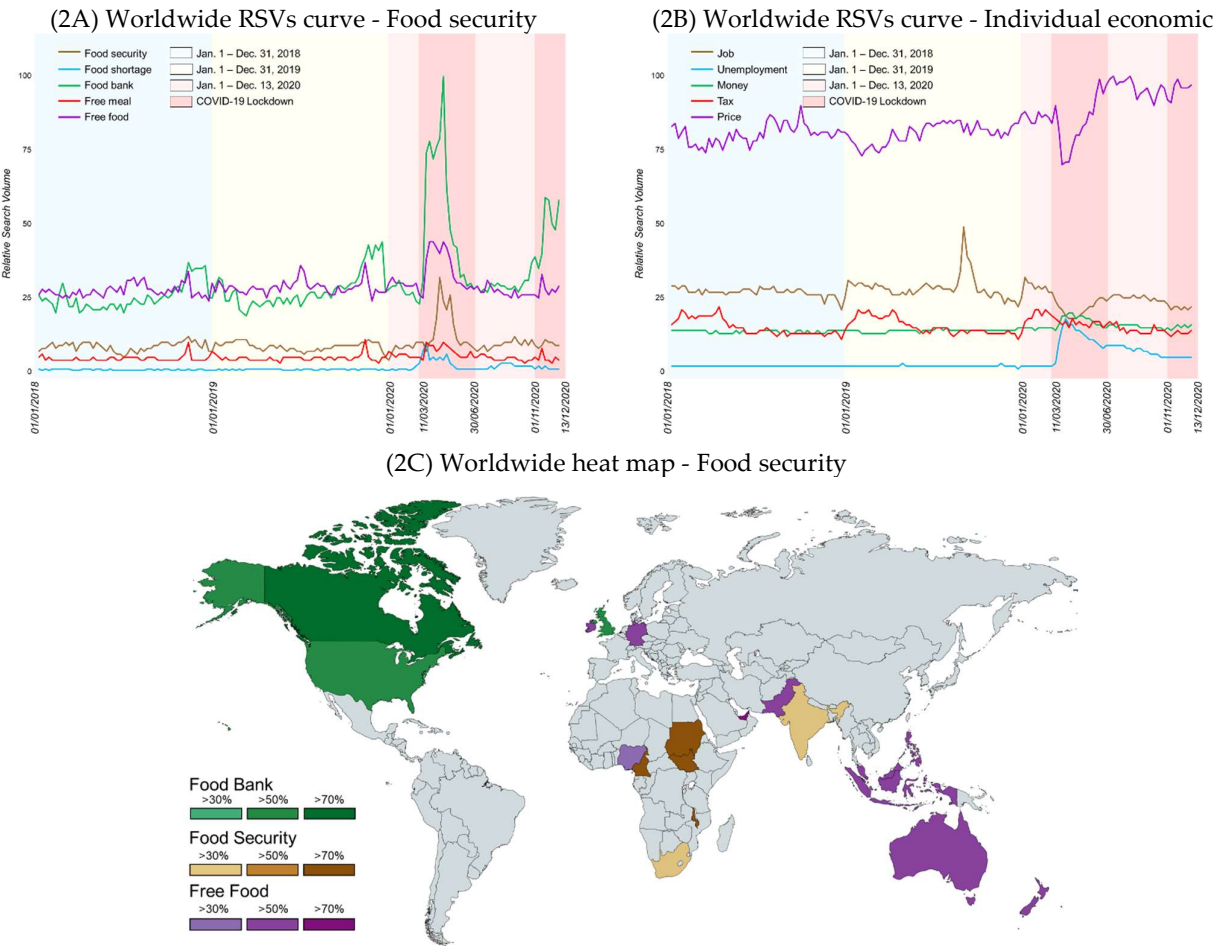

Figure 2. Worldwide trend curves for food security (2A) and individual economic factors (2B), search terms from January 1, 2018, to December 13, 2020. Worldwide heat map of the high search volumes geography in food security (2C) search terms during the first global lockdown period, from March 11, 2020, to June 30, 2020. Color intensity represents different levels of percentage of searches.

3.2. Health- and food-safety concerns

Regarding health concerns, especially with the issue of immune-boosting nutrients was detailly analyzed. An analogous event was observed during the first global COVID-19 lockdown, as our immune system is the first body response to the virus's pervasion, the terms of "vitamin C" and "immunity" were dramatically increased in searching, and then chronologically reduced to their average volumes (Figure 3A). In addition, the general keyword of "vitamin" was also increasingly sought out and decreased during the global lockdown lifting. However, their volumes were enjoyed at a higher level comparing with those in the previous years and were more likely to rebound during the second quarantine. The worldwide heat map showed that Southeast Asia countries had the highest interests for "vitamin C", other top-searching countries were in South Asia, South Africa, North and Central America, as well as Arabian Peninsula. Besides, people worldwide were also more probably to look for other immune-boosting nutrients, such as "vitamin D" and "zinc". Individually, the term "Vitamin D" was more likely to increase their search volumes during the second lockdown, and during the end of the year when aligned with the less sunlight season in many European countries such as UK, Ireland, Russia, Central European. Interestingly, similar keenness for "vitamin D' was also found in the Middle East, North Africa, Latin America. Meanwhile, Chilean, Bolivian, and French habitants paid more keenness for "zinc" (Figure 3C). Figure 3B describes the global habitants' interest in food safety. Notably, RSVs of "food poisoning" was substantially declined during the worldwide lockdown, gradually rebounded in the post-confinement, and tended to relapse during the second lockdown. During the interval, RSVs of "food storage containers" were slightly increased, "sanitation" was considerably fluctuated during the confinement, whereas interest in other related terms like "food safety" and "food packaging" was not much fluctuated during the quarantine, as well as during the surveyed years.

(3A) Worldwide RSVs curve - Vitamin

(3B) Worldwide RSVs curve - Food safety
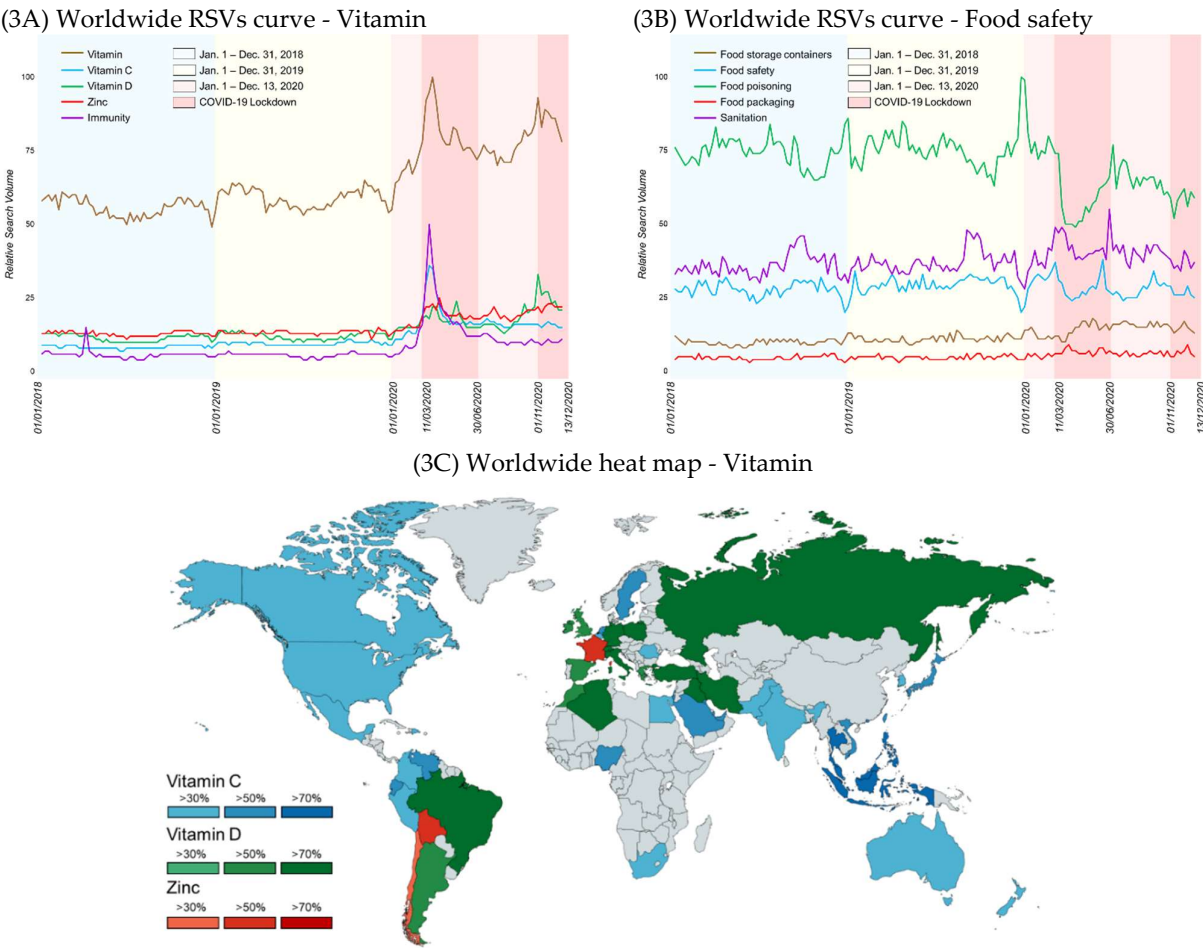

(3C) Worldwide heat map - Vitamin

Figure 3. Worldwide trend curves for immune-boosting nutrients (3A) and food safety (3B) search terms from January 1, 2018, to December 13, 2020. Worldwide heat map of the high search volumes geography in vitamin (3C), search terms during the first global lockdown period, from March 11, 2020, to June 30, 2020. Color intensity represents different levels of percentage of searches.

3.3. Food choices and preferences

For dietary, the RSVs of five main items in the "starchy food" was first examined. Outstandingly, consumers worldwide were more likely to search for all kinds of staples such as "bread", "rice", "pasta", "potato" and "flour" during the first lockdown. These immediate effects were rapidly declined during the post-lockdown. However, these volumes stayed at a higher horizontal line than those in previous years (Figure 4A-1). The global map of food staple was further analyzed (Figure 4A-2). The results revealed the interest's distribution of the main carbohydrate-sources, particularly, "rice" was got more keenness for rice-exporter countries like Vietnam, Thailand, India, Pakistan, whereas citizens from Italy, Belgium, Netherlands, were more potential to look for "pasta". Meantime, people from Scandinavia region, Eastern Europe were more likely to seek "potato" Interestingly, "bread" was occupied in most people worldwide interest with related high search volumes in many countries around the globe.

Next, the main protein sources were investigated (Figure 4B-1), people globe notably paid high interest in "chicken", "egg" and "fish", which their RSVs were considerably increased during the first lockdown, and chronologically decreased during the lockdown easement. Nevertheless, these volumes were enjoyed at higher figures compared with reference years. Predictively, it was more likely to re-hike during the second lockdown Under other conditions, RSVs of "beef" and "pork" were kept unfluctuating during the COVID-19 pandemic. The global distribution of those concerns was illustrated in Figure 4B-2. Detailly, "fish" was the major keenness for South and Southeast Asian habitats (except for the Filipino), Middle Easterners, Russian, and German. Meanwhile, most European countries, Oceanic, South Africa, American search for "chicken", whereas "egg" was highly searched in Chile, Argentina, and Arabic Peninsula.

Figure 4C-1 describes the degree of RSVs fluctuation of milk and dairy products during the COVID-19 pandemic. RSVs curves were relatively sharpened in "milk", "cheese", "yogurt" and "butter", whereas a lesser amplitude was reported in "ice cream". These changes were lessened during the lifting period and were more likely to rebound in the second lockdown. Regarding geographical distribution, habitants living in the US and Canada, Southern Eastern Europe, NZ, South Korea, and Japan were more probably to search for "cheese", notwithstanding, the majority of rest of the world looked for "milk", with the top highest volume were observed in South and Southeast Asia, Iran, Brazil, Peru, and Venezuela (Figure 4C-2).

Similar to other food groups, RSVs curves showed a razor-sharp risen interest in keywords of "vegetable" and "fruit" during the first lockdown, whereas "mushroom", "bean" and lentil" were also slightly extended in the same period (Figure 4D-1). Selectively, consumer living in Central and Southern American, Southern Europe were more likely to concern in "fruit", whereas habitants living in the greater number countries around the world keened on "vegetables" (Figure 4D-2). These increase volumes gradually returned to their average searches during the post-lockdown.

Lastly, the common items categorized into the "cooking-oil" group were also extensively examined. Figure 4E-1 illustrates that global searches for "olive oil", "coconut oil" and "lard" were dramatically increased, whilst "palm oil" and "soybean oil" remained unalterably during the COVID-19 preventive measures adoption. Interestingly, people in Western Europe, North America, North Africa, Middle East, and island countries such as Japan, Taiwan, Indonesia, Malaysia, and Australia were more seemingly to search for "olive oil". On the other hand, citizens living in Eastern Europe and Russia, Central, and South America, South Asia, and South Africa were more likely to seek "coconut oil". These impacts were chronologically weakened during lockdown relief, nevertheless, it was more potentially to recrudesce during the second lockdown (Figure 4E-2).

(4A-1) Worldwide RSVs curve - Starchy food
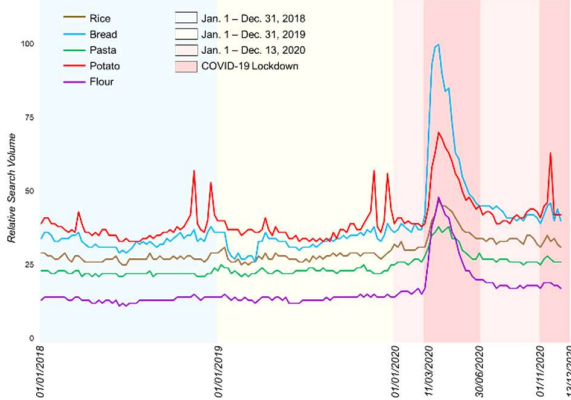
(4A-2) Worldwide heat map - Starchy food
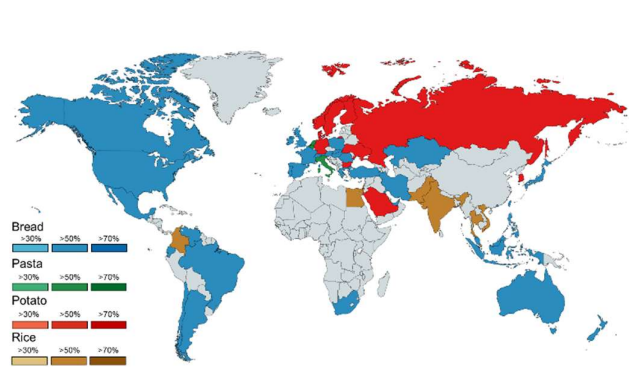
(4B-1) Worldwide RSVs curve - Meat

(4B-2) Worldwide heat map - Meat
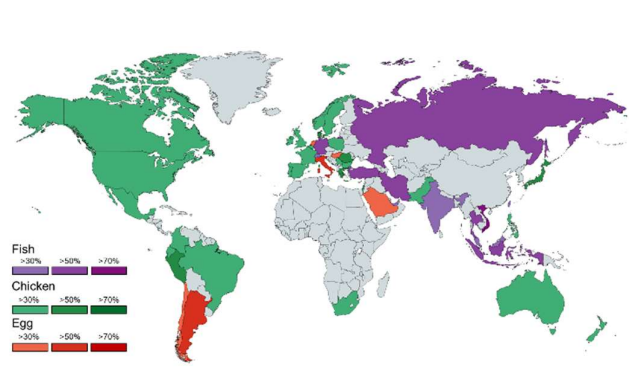
(4C-1) Worldwide RSVs curve - Dairy products
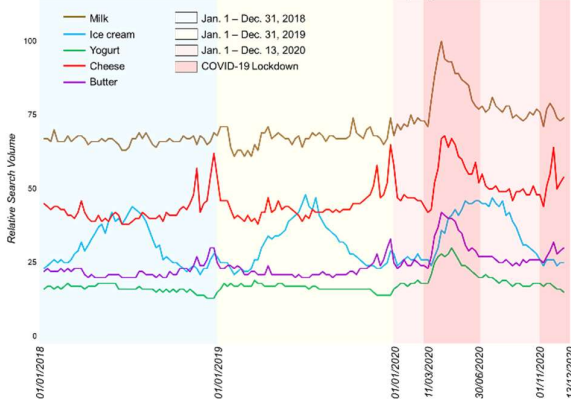
(4C-2) Worldwide heat map - Dairy products
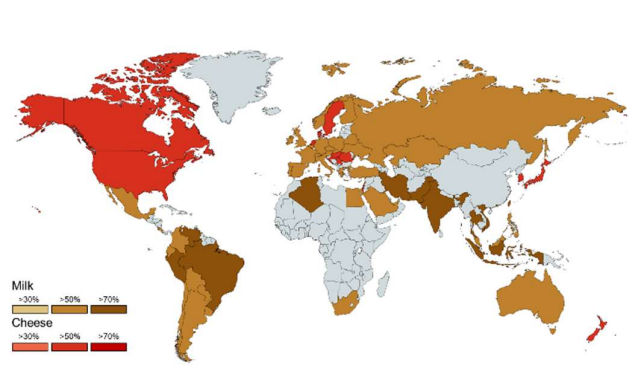
(4D-1) Worldwide RSVs curve - Vegetables & fruits
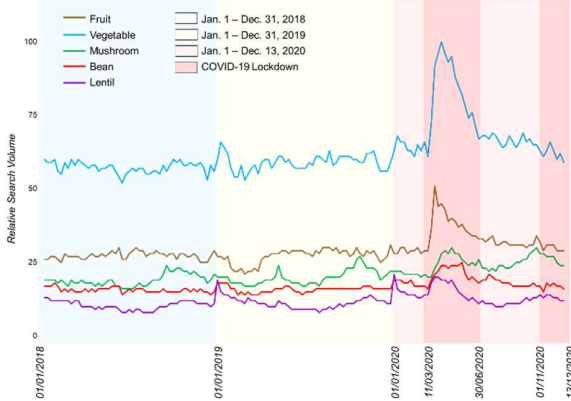
(4D-2) Worldwide heat map - Vegetables & fruits
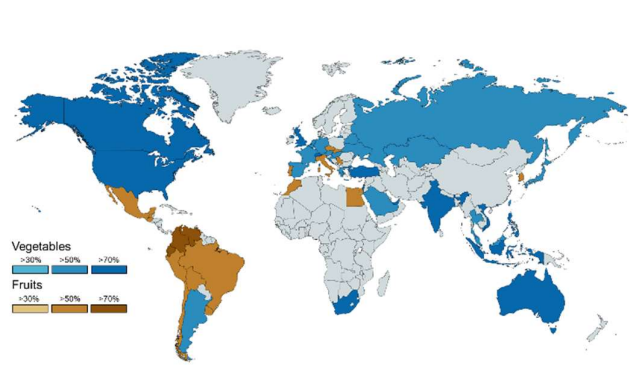
(4E-1) Worldwide RSVs curve - Cooking-oil
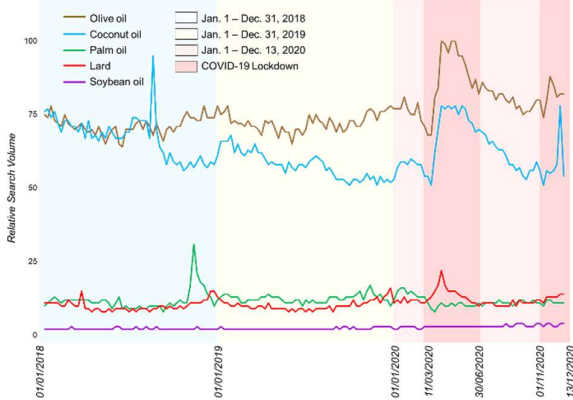
(4E-2) Worldwide heat map - Cooking-oil

(4F-1) Worldwide RSVs curve - Canned foods
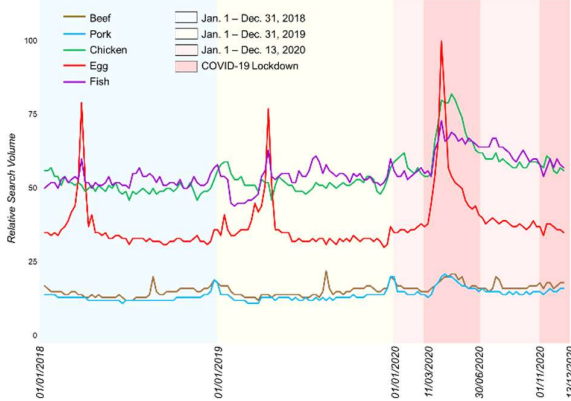

(4F-2) Worldwide heat map - Canned foods
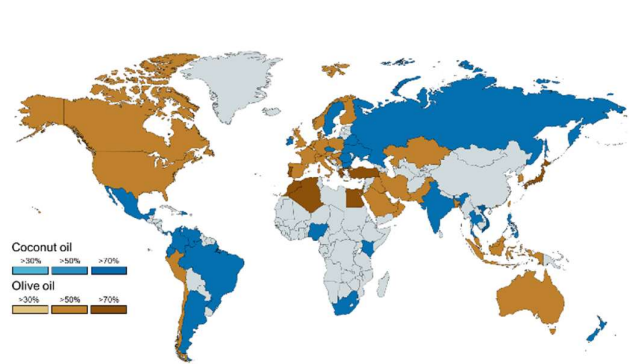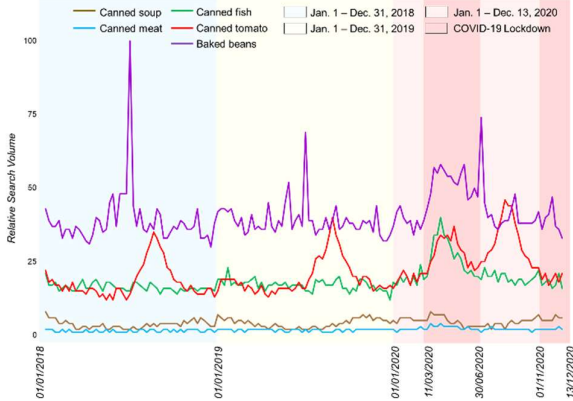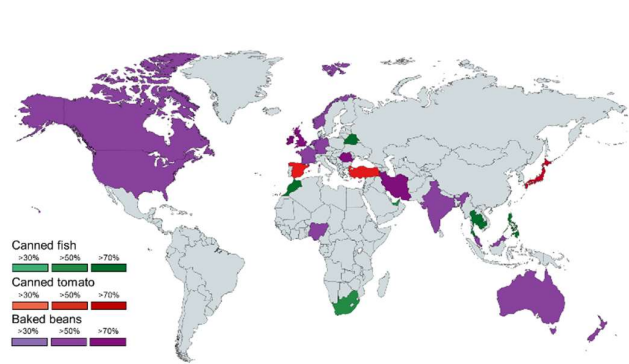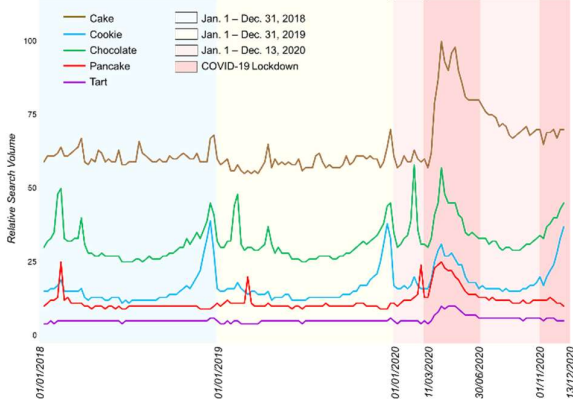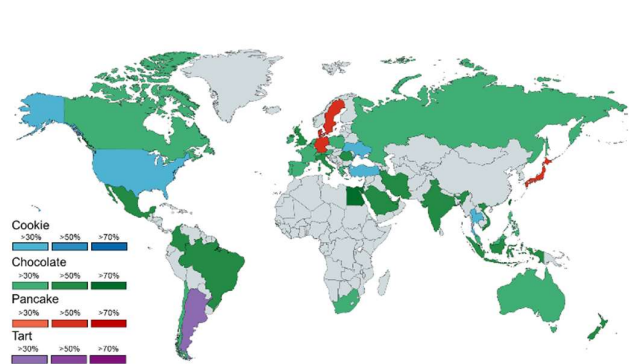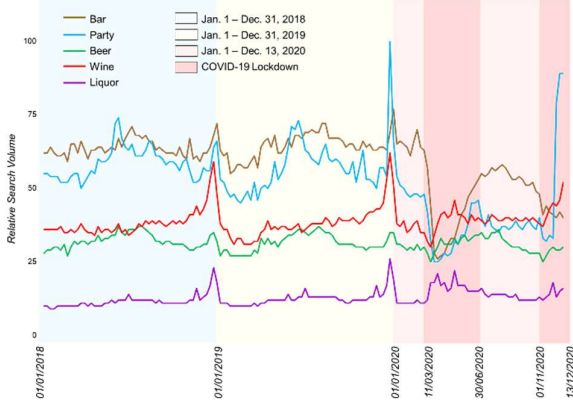

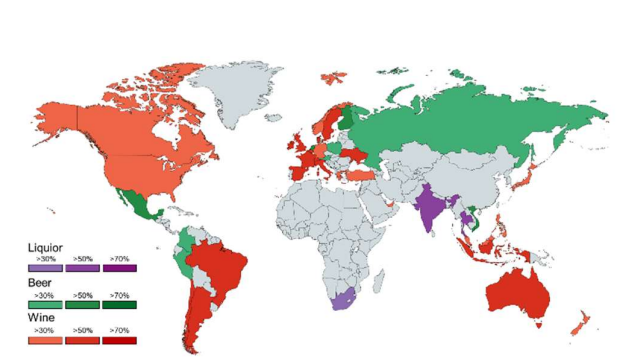(4G-1) Worldwide RSVs curve - Sugary foods

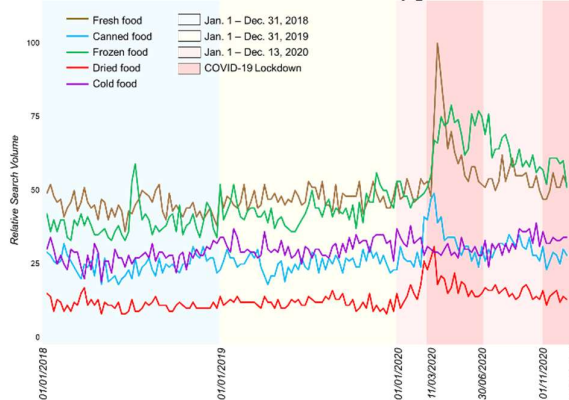(4G-2) Worldwide heat map - Sugary foods

(4H-1) Worldwide RSVs curve - Alcoholic beverages

(4H-2) Worldwide heat map - Alcoholic beverages

(4I) Worldwide RSVs curve - Food types

(4J) Worldwide RSVs curve - Food sourcing
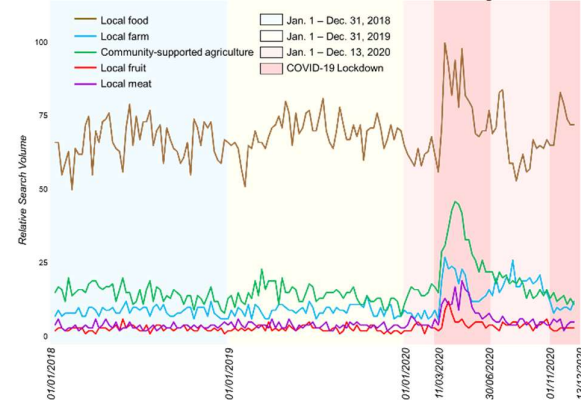
Figure 4. Worldwide trend curves for starchy food (4A-1), meat (4B-1), milk and dairy products (4C-1), vegetables and fruits (4D-1), cooking-oi (4E-1), canned foods (4F-1), sugary foods (4G-1), alcoholic beverages (4H-1), food types (4I), food sourcing (4J), search terms from January 1, 2018, to December 13, 2020. Worldwide heat map of the high search volumes geography in starchy food (4A-2), meat (4B-2), milk and dairy products (4C-2), vegetables and fruits (4D-2), cooking-oi (4E-2), canned foods (4F-2), sugary foods (4G-2), alcoholic beverages (4H-2), search terms during first global lockdown period, from March 11, 2020, to June 30, 2020. Color intensity represents different levels of percentage of searches.

Five issues related to food types were explored in the present study. First, canned foods were investigated (Figure 4F-1). With the looming pandemic, consumer worldwide were more likely to look for long-lasting food products for reducing out-going activities and food-stocking purposes, which linked to the increased searches of all kinds of canned foods whether they were "canned soup", "canned fish", "canned meat", "canned tomato" and "baked beans" during the lockdown. These effects kept continuously and just gradually declined during the post-lockdown. However, these volumes were at higher ranges than those in previous years. The worldwide heat map (Figure 4F-2) illustrated that "canned fish" was got more interest from Thailander, Filipino, Moroccan and South African, whilst citizens from Spain, Turkey and Japan were more likely to seek for "canned tomato". Meanwhile, people from the rest of the world like North America, Europe, South Africa, the Middle East, and the Oceanic region were more probably to find "baked beans".

Sugary foods, which is one of the most popular food products was paid attention during confinement were examined (Figure 4G-1). Undoubtedly, all items in this group whatsoever they were "cake", "cookie", "chocolate", "pancake" and "tart" were considerably risen during the three months of global quarantine, gradually downed during the lockdown lifting and tended to increase during the next lockdown. While the majority of countries worldwide interested in chocolate, Scandinavian habitants and Japanese were more likely to search for the "pancake". US, Ukraine, Turkey, and Thailand consumers were more possibly to look for "cookies", whereas, Chilean are keen on "tart" during a similar period (Figure 4G-2).

Next, alcoholic beverages and their related activities were explored (Figure 4H-1). Certainly, COVID-19 lockdown with their shutdown measures has restricted the opening of "bar" and "party" that leads these RSVs sharply reduced during the quarantine. These changes tended to recover during the post-lockdown, however, their related volumes were significantly lower than those in previous years. Contrastingly, although some alcoholic drink bans were adopted in many places around the world, consumers worldwide were more likely to seek out "wine" and "liquor" rather than "beer" during the same period. These searches were still high even enjoyed at a higher level than those in reference years. The worldwide heat map showed different keenness in these kinds of drinks (Figure 4H-2). Thailander, Indian, and South African were more likely to search for "liquor", whereas Vietnam, Eastern Europe, and Central American countries were more probably look for "beer". Interestingly, many countries around the world,

from North and South America to Western Europe and further to Southeast Asia and Pacific were more seemingly to seek "wine" during the global lockdown period.

Food types and food sourcing were further analyzed (Figure 4I and Figure 4J). In this graph, not only for canned foods, but consumers worldwide also become increasingly sought out for storable commodity food items, whether that food was "fresh", "frozen", "canned", or "dried" food. These searches started to rise during the first week of lockdown and gradually reduced after a month, whereas "frozen food" increased and remained at high volumes during the whole quarantine period and even throughout the lockdown easement.

Along with the concern about the foodstuff storability, people around the world also started to look for more local food sources with reasonable prices rather than imported-foods during the lockdown (Figure 4J). All terms related to "local farm" and "local food", "local fruit" and "local meat" enjoyed moderate search interest in this period. Regarding community-supported agricultural operations (CSAs), the searches also spike during the confinement which reflects the strong connection and mutual understanding between consumers and farmers as well.

3.4. Social and Individual factors

Social factors related to eating behavior including eating establishment, home-cooking, and food-delivery services were investigated and the results were delivered in Figure 5A. During the previous reference year, the RSVs' of home-cooking and "restaurant" keywords were annually stable with the increases during the new year season. However, the COVID-19 pandemic and lockdown have dramatically changed the global keenness, particularly, people worldwide showed their growing concern for "cooking" at home by searching for "recipe". In the meantime, the term "restaurant" was dramatically decreased during the same period. Remarkably, "delivery" and "take-out" were increased to some extent. These effects were slowly released during the lockdown easement.

For individual factors, COVID-19 has dramatically changed people weight's concerns (Figure 5B). The yearly fluctuation was analyzed with the highest interests was arisen during the new year season with keyword "weight", "weight gain" and "calories". However, during the first month of the COVID-19 lockdown period, the global concern regarding these issues was sharply dropped. Global habitats were more likely to concern with "weight loss", "weight", "calorie" and "aerobic exercise", after a month of confinement adoption with the high RSVs were recorded at the end of the second and third month. Noticeably, These volumes escalated at a higher level comparing with those in reference years. Oppositely, "Weight gain" was not got more attention during the restricted period. These concerns were gradually scaled down to their average at the pre-pandemic stage and were possibly to rebound at the end of the year.

(5A) Social factors (Food services and home-cooking)   (5B) Individual Factors (Weight concerns)
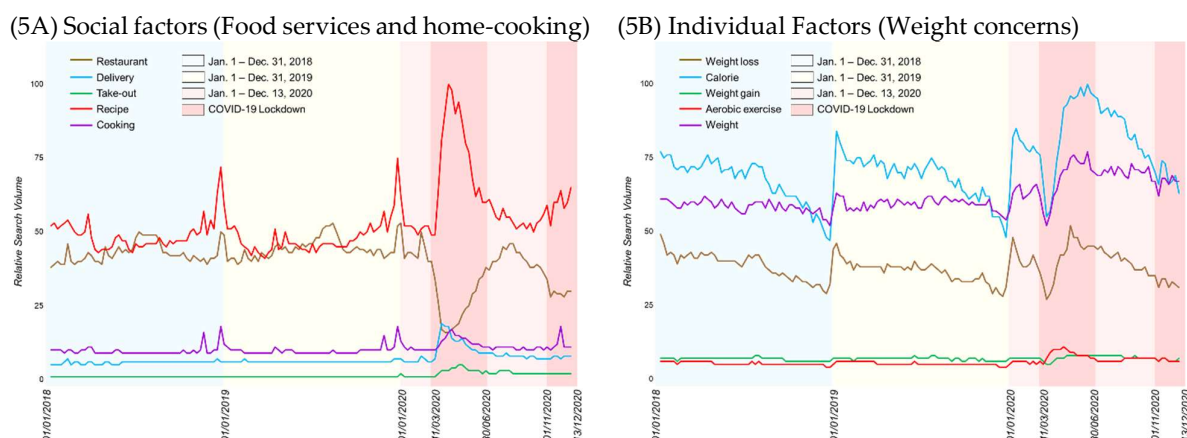
Figure 5. Worldwide trend curves for social factors (5A) and individual factors (5B), search terms from January 1, 2018, to December 13, 2020.

3.5. Lifestyle factors

We next examined some search interest related to lifestyle factors. COVID-19 has significantly changed people's behavior toward food purchasing (Figure 6A). Consumer worldwide increasingly sought out for "grocery", "market", "online shopping", "supermarket", where provides the necessary merchandises (foods and household supplies) for daily life whereas "shopping mall" - the place for further hanging out, shopping and eating activities were dramatically declined during the global lockdown and even during the new year holiday.

Regarding routine physical activities and related sports equipment, the RSVs of the high-risk of COVID-19 transmission activities or shared-physical activities such as "gym" and "swimming" were relatively declined, whereas private-physical activities like "running", "walking (jogging)", and "cycling" were apparently increased (Figure 6B). These acute effects dwindled during the easement period. Following the restrictive measures, people globe keened on looking for sports equipment. Notably, the interest for all sports equipment such as "yoga mat", "treadmill", "stationary bicycle" or "dumbbell" was dramatically risen during the curfew period, although "health club" was decreased to a certain degree (Figure 6C). These interests were continuously extended through post-lockdown.

Regarding leisure activities, a sharp escalation of interest in contactless activities like "video-game", "book" was observed. Nevertheless, these immediate accouterments rapidly declined during post-lockdown. In the meantime, contact-activities such as "movie theatre" and "concert" were steeply declined during the COVID-19 pandemic lockdown. Other terms related to leisure activities like "music" was unwavering throughout the pandemic (Figure 6D).

3.6. Psychological factors

Lastly, we explored the global interest in searching for psychological symptoms. Social distancing and restrictive measures sound stressful, hence, during confinement, people worldwide paid more interest in searching for psychological symptoms such as "anxiety", "isolation", "boredom" and "insomnia", whereas the keyword for chronic psychological symptoms like "depression" was dramatically increased after the lockdown easement (Figure 7A). Surprisingly, compared to those in the pre-pandemic period, the volume sizes of "anxiety" and "isolation" were more likely to remain at a higher level throughout the year. Worldwide heat map indicated that people living in Americas, Europe, Oceanic region were more likely to search for "anxiety", whereas those in Africa, Middle East, and Russia tend to look for "depression" keyword. In the meantime, Thailander and Indonesian paid more concern to "insomnia" (Figure 7B).

(6A) Food Purchasing Establishments
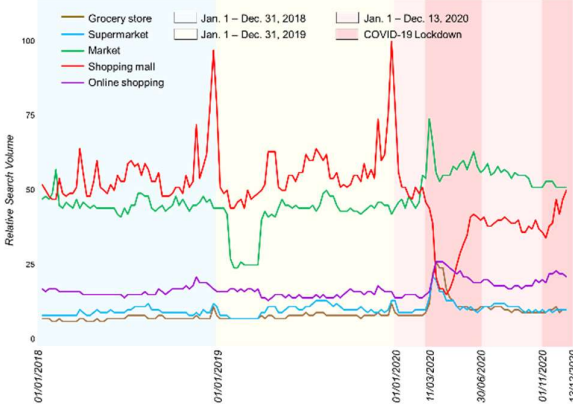
(6B) Physical activities
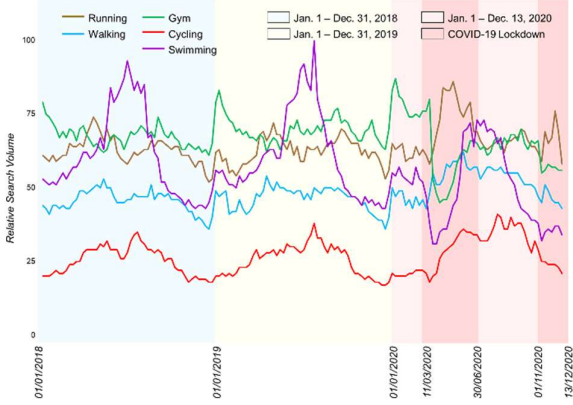
(6C) Sports equipment

(6D) Leisure activities
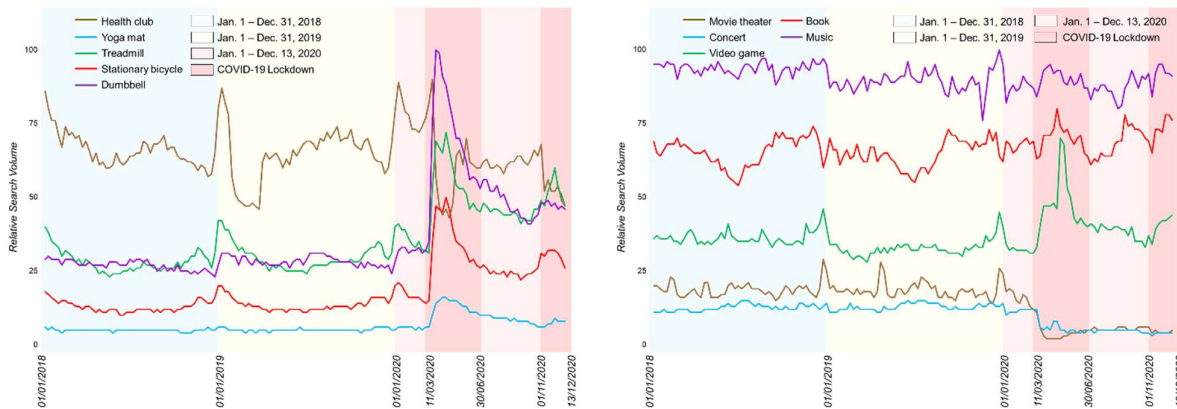
Figure 6. Worldwide trend curves for lifestyle behavior: food purchasing establishment (6A), physical activities (6B), sports equipment (6C), leisure activities (6D), search terms from January 1, 2018, to December 13, 2020.

(7A) Worldwide RSVs curve - Psychology   (7B) Worldwide heat map - Psychology
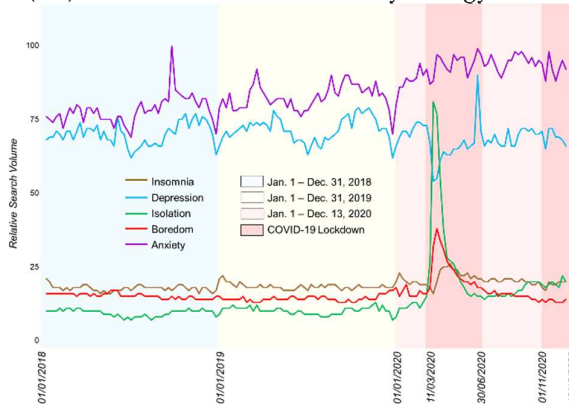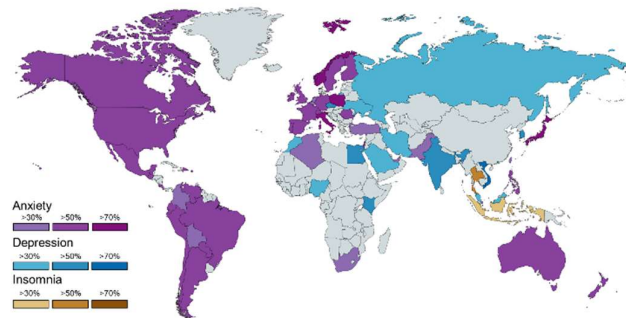
Figure 7. Worldwide trend curves for psychological factors (7A), search terms from January 1, 2018, to December 13, 2020; and its worldwide heat map of the high search volumes geography (7B), search terms during first global lockdown period, from March 11, 2020, to June 30, 2020. Color intensity represents different levels of percentage of searches.

3.7. Correlations between RSVs of Eating Behavior and its Related Factors and COVID-19 Statistics

There were strong either positive or negative correlations between COVID-19 daily confirmed cases with search volumes of examined keywords explained the increase or decrease of consumer's interest strongly depended on the number of new daily cases (Table 2). Particularly, Spearman's correlation analysis revealed the strongest positive correlation with variables in each factor's category as following: (1) environmental and economic factors (food shortage: $r = 0.619$, food bank: $r = 0.533$, unemployment: $r = 0.877$, money: $r = 0.744$, price: $r = 0.623$, all $p < 0.001$); (2) health- and food-safety concerns (food storage container: $r = 0.712$, food packaging: $r = 0.612$, vitamin: $r = 0.790$, vitamin C: $r = 0.789$, vitamin D: $r = 0.786$, zinc: $r = 0.816$, immunity: $r = 0.783$, all $p < 0.001$); (3) food choices and preference (rice: $r = 0.773$, bread: $r = 0.768$, pasta: $r = 0.772$, potato: $r = 0.645$, flour: $r = 0.790$, pork: $r = 0.661$, chicken: $r = 0.706$, fish: $r = 0.686$, milk: $r = 0.767$, cheese: $r = 0.632$, butter: $r = 0.686$, fruit: $r = 0.708$, vegetable: $r = 0.700$, mushroom: $r = 0.698$, bean: $r = 0.629$, olive oil: $r = 0.666$, soybean oil: $r = 0.762$, cake: $r = 0.682$, pancake: $r = 0.663$, tart: $r = 0.663$, fresh food: $r = 0.652$, frozen food: $r = 0.747$, dried food: $r = 0.643$, all $p < 0.001$); (4) social factors (deliver: $r = 0.811$, take-out: $r = 0.890$, recipe: $r = 0.626$, cooking: $r = 0.604$, all $p < 0.001$); (5) individual factors (weight: $r = 0.72$, aerobic exercise: $r = 0.689$); (6) lifestyle factors (grocery store: $r = 0.731$, market: $r = 0.737$, online shopping: $r = 0.634$,

yoga mat: r = 0.801, treadmill: r = 0.755, stationary bicycle: r = 0.757, dumbbell: r = 0.775, all p < 0.001); (6) psychological factors (insomnia: r = 0.594, isolation: r = 0.791, anxiety: r = 0.757, all p < 0.001).

On the other hands, the moderate negative correlation were observed in variables in each specific category as follows: (1) environmental and economic factors (job: r = -0.624, p < 0.001); (2) health- and food-safety concerns (food poisoning: r = -0.647, p < 0.001); (3) food choices and interest (palm oil: r = -0.277, p = 0.001); (4) social factors (restaurant: r = -0.544, shopping mall: r = -0.739, p < 0.001); (5) lifestyle factors (gym: r = -0.429, swimming: r = -0.338, movie theatre: r = -0.779, concert: r = -0.765, bar: r = -0.704, party: r = -0.644, all p < 0.001). Similar observations were noticed for COVID-19 cumulative cases or "coronavirus RSV".

3.8 Differences of RSVs of Eating Behavior and its Related Factors before and during COVID-19 Pandemic

Table 2 describes the results of a repeated-measures ANOVA, followed by Bonferroni Post-hoc test to compare the differences of RSVs in the specific time (i.e. 2018 and 2019 are control years, whereas 2020 is COVID-19 pandemic year). The results emphasize that the COVID-19 pandemic has significantly changed the people's worldwide online interests in all eating behavior component factors. Specifically, compare with the average RSVs of the period of two consecutive years, during COVID-19 pandemic, people around the world paid more keenness in searching in specific keywords with the RSVs increase as following (Figure 8): (1) environmental and economic factors (unemployment: +269%, food shortage: +180%, food bank: +50%); (2) health- and food-safety concerns (immunity: +138%, vitamin C: +90%, vitamin D: +55%, zinc: +47%, food storage containers: +40%, food packaging: +31%); (3) food choices and interest (local meat: +84%, frozen food: +67%, CSA: +65%, flour: +66%, bread: +53%, soybean oil: +45%, local fruit: +43%, canned tomato: +42%, refrigerated food: +41%, canned meat: +39%, pancake: +37%, cookie: +29%, butter: +29%, canned fish: +29%, liquior: +20%); (4) social and individual factors (take-out: +128%, deliver: +53%, recipe: +29%); (6) lifestyle factors (stationary bicycle: +110%, dumbbell: +89%, yoga mat: +84%, treadmill: +65%, grocery store: +51%, aerobic exercise: +33%); (6) psychological factors (isolation: +113%). Contrarily, COVID-19 pandemic lessen the global citizen 's concern by reducing their seeking for distinct terms as follow: (1) environmental and economic factors (job: -14%); (2) health- and food-safety concerns (food poisoning: -14%); (3) food choices and interest (dried food: -36%, palm oil: -7%, canned food: -6%); (4) social and individual factors (restaurant: -21%); (5) lifestyle factors (movie theatre: -64%, concert: -51%,shopping mall: -29%, party: -28%, bar: -23%, swimming: -18%).

Table 1. Spearman's correlation coefficients of eating behavior and its related factors search terms with daily confirmed COVID-19 cases, cumulative COVID-19 cases, and coronavirus Google Trends search terms, examined period: January 1, 2020, to December 13, 2020.

	Term	COVID-19 Cumulative Cases		COVID-19 Daily Cases		"Coronavirus" RSV	
		r	p-value	r	p-value	r	p-value
	Food security						
Environment and economic	Food security	0.292	<0.001	0.290	<0.001	0.306	<0.001
	Food shortage	0.622	<0.001	0.619	<0.001	0.657	<0.001
	Food bank	0.532	<0.001	0.533	<0.001	0.527	<0.001
	Food meal	0.164	0.042	0.167	0.039	0.336	<0.001
	Free food	0.020	0.803	0.024	0.770	0.172	0.033
	Individual economic						
	Job	-0.625	<0.001	-0.624	<0.001	-0.587	<0.001
	Unemployment	0.877	<0.001	0.877	<0.001	0.871	<0.001
	Money	0.744	<0.001	0.744	<0.001	0.780	<0.001
	Tax	-0.016	0.841	-0.016	0.842	0.143	0.077
	Price	0.625	<0.001	0.623	<0.001	0.502	<0.001
	Food safety						
Health and food safety	Food storage containers	0.712	<0.001	0.712	<0.001	0.663	<0.001
	Food safety	-0.156	0.054	-0.160	0.048	-0.104	0.198
	Food poisoning	-0.646	<0.001	-0.647	<0.001	-0.604	<0.001
	Food packaging	0.613	<0.001	0.612	<0.001	0.631	<0.001

Food choices and preferences

Sanitation	0.427	<0.001	0.424	<0.001	0.496	<0.001
Immune-boosting nutrients						
Vitamin	0.791	<0.001	0.790	<0.001	0.791	<0.001
Vitamin C	0.789	<0.001	0.789	<0.001	0.826	<0.001
Vitamin D	0.787	<0.001	0.786	<0.001	0.776	<0.001
Zinc	0.816	<0.001	0.816	<0.001	0.801	<0.001
Immunity	0.783	<0.001	0.783	<0.001	0.835	<0.001
Starchy food						
Rice	0.773	<0.001	0.773	<0.001	0.803	<0.001
Bread	0.767	<0.001	0.768	<0.001	0.799	<0.001
Pasta	0.773	<0.001	0.772	<0.001	0.823	<0.001
Potato	0.644	<0.001	0.645	<0.001	0.663	<0.001
Flour	0.790	<0.001	0.790	<0.001	0.821	<0.001
Meat						
Beef	0.558	<0.001	0.560	<0.001	0.555	<0.001
Pork	0.661	<0.001	0.661	<0.001	0.680	<0.001
Chicken	0.705	<0.001	0.706	<0.001	0.744	<0.001
Egg	0.552	<0.001	0.552	<0.001	0.619	<0.001
Fish	0.687	<0.001	0.686	<0.001	0.702	<0.001
Milk and dairy products						
Milk	0.766	<0.001	0.767	<0.001	0.798	<0.001
Ice cream	0.238	0.003	0.238	0.003	0.281	<0.001
Yogurt	0.562	<0.001	0.563	<0.001	0.679	<0.001
Cheese	0.630	<0.001	0.632	<0.001	0.634	<0.001
Butter	0.685	<0.001	0.686	<0.001	0.705	<0.001
Vegetables and fruits						
Fruit	0.707	<0.001	0.708	<0.001	0.738	<0.001
Vegetable	0.700	<0.001	0.700	<0.001	0.762	<0.001
Mushroom	0.697	<0.001	0.698	<0.001	0.654	<0.001
Bean	0.627	<0.001	0.629	<0.001	0.703	<0.001
Lentil	0.414	<0.001	0.414	<0.001	0.496	<0.001
Cooking-oil						
Olive oil	0.664	<0.001	0.666	<0.001	0.648	<0.001
Coconut oil	-0.008	0.924	-0.005	0.949	0.092	0.257
Palm oil	-0.278	<0.001	-0.277	0.001	-0.274	0.001
Lard	0.499	<0.001	0.500	<0.001	0.540	<0.001
Soybean oil	0.760	<0.001	0.762	<0.001	0.718	<0.001
Canned food products						
Canned food	0.256	0.001	0.259	0.001	0.266	0.001
Canned meat	0.437	<0.001	0.437	<0.001	0.518	<0.001
Canned fish	0.559	<0.001	0.559	<0.001	0.661	<0.001
Canned tomato	0.548	<0.001	0.547	<0.001	0.579	<0.001
Baked beans	0.314	<0.001	0.313	<0.001	0.416	<0.001

Food choices and preferences (continue)

Sugary foods						
Cake	0.681	<0.001	0.682	<0.001	0.659	<0.001
Cookie	0.498	<0.001	0.500	<0.001	0.516	<0.001
Chocolate	0.420	<0.001	0.422	<0.001	0.458	<0.001
Pancake	0.663	<0.001	0.663	<0.001	0.754	<0.001
Tart	0.661	<0.001	0.663	<0.001	0.661	<0.001
Alcoholic beverages						
Bar	-0.704	<0.001	-0.704	<0.001	-0.670	<0.001
Party	-0.643	<0.001	-0.644	<0.001	-0.716	<0.001
Beer	-0.204	0.011	-0.202	0.012	-0.159	0.049
Wine	0.346	<0.001	0.347	<0.001	0.253	<0.003
Liquior	0.466	<0.001	0.467	<0.001	0.471	<0.001
Food types						
Fresh food	0.654	<0.001	0.652	<0.001	0.695	<0.001
Canned food	0.538	<0.001	0.536	<0.001	0.589	<0.001
Frozen food	0.747	<0.001	0.747	<0.001	0.766	<0.001
Dried food	0.643	<0.001	0.643	<0.001	0.723	<0.001
Cold food	0.340	<0.001	0.340	<0.001	0.248	0.002
Food sourcing						
Local food	0.086	0.291	0.087	0.285	0.115	0.154
Local farm	0.550	<0.001	0.550	<0.001	0.529	<0.001
Community-supported agriculture	0.320	<0.001	0.319	<0.001	0.472	<0.001
Local fruit	0.414	<0.001	0.415	<0.001	0.473	<0.001

	Local meat	0.499	<0.001	0.499	<0.001	0.574	0.002

Social and Individual factors	**Social factors**					
	Restaurant	-0.545	<0.001	-0.544	<0.001	-0.560	<0.001
	Deliver	0.810	<0.001	0.811	<0.001	0.811	<0.001
	Take-out	0.889	<0.001	0.890	<0.001	0.855	<0.001
	Recipe	0.626	<0.001	0.626	<0.001	0.643	<0.001
	Cooking	0.602	<0.001	0.604	<0.001	0.630	<0.001
	Individual factors					
	Weight loss	0.079	0.333	0.079	0.333	0.162	0.045
	Calorie	0.470	<0.001	0.470	<0.001	0.518	<0.001
	Weight gain	0.279	<0.001	0.279	<0.001	0.309	<0.001
	Aerobic exercise	0.689	<0.001	0.689	<0.001	0.699	<0.001
	Weight	0.703	<0.001	0.702	<0.001	0.653	<0.001
Lifestyle factors	**Food purchasing establishment**					
	Grocery store	0.730	<0.001	0.731	<0.001	0.754	<0.001
	Supermarket	0.331	<0.001	0.332	<0.001	0.402	<0.001
	Market	0.739	<0.001	0.737	<0.001	0.757	<0.001
	Shopping mall	-0.739	<0.001	-0.739	<0.001	-0.747	<0.001
	Online shopping	0.633	<0.001	0.634	<0.001	0.587	<0.001
	Physical activities					
	Running	0.351	<0.001	0.351	<0.001	0.348	<0.001
	Walking	0.469	<0.001	0.469	<0.001	0.503	<0.001
	Gym	-0.428	<0.001	-0.429	<0.001	-0.352	<0.001
	Cycling	0.354	<0.001	0.352	<0.001	0.295	<0.001
	Swimming	-0.337	0.001	-0.338	<0.001	-0.293	0.001
	Sports equipment					
	Heath club	-0.319	<0.001	-0.322	<0.001	-0.227	0.005
	Yoga mat	0.800	<0.001	0.801	<0.001	0.823	<0.001
	Treadmill	0.754	<0.001	0.755	<0.001	0.752	<0.001
	Stationary bicycle	0.756	<0.001	0.757	<0.001	0.755	<0.001
	Dumbbell	0.774	<0.001	0.775	<0.001	0.804	<0.001
	Leisure activities					
	Movie theatre	-0.779	<0.001	-0.779	<0.001	-0.778	<0.001
	Concert	-0.766	<0.001	-0.765	<0.001	-0.709	<0.001
	Video game	0.496	<0.001	0.496	<0.001	0.474	<0.001
	Book	0.424	<0.001	0.423	<0.001	0.367	<0.001
	Music	-0.289	<0.001	-0.287	<0.001	-0.313	<0.001
Psychology	**Psychological factors**					
	Insomnia	0.593	<0.001	0.594	<0.001	0.624	<0.001
	Depression	-0.248	0.007	-0.248	0.006	-0.301	0.001
	Isolation	0.790	<0.001	0.791	<0.001	0.793	<0.001
	Boredom	0.215	<0.001	0.215	<0.001	0.429	<0.001
	Anxiety	0.758	<0.001	0.757	<0.001	0.753	<0.001

te repeated measures ANOVA and Bonferroni Post-hoc Test Results examined period: January 1to December 13 in different years (2018, 20

Mean RSV±SE (Jan. 1- Nov.15)			ΔMean RSV±SE (95% Confidence Interval)				Mauchly's W		Greenhouse-G
2018	2019	2020	2020 vs. 2018	p-value	2020 vs. 2019	p-value	χ2(2)	p-value	df
			Food security						
8.68±0.22	8.74±0.18	10.86±0.70	2.18±0.67 (0.51-3.85)	0.006	2.12±0.75 (0.27-3.97)	0.020	0.202	<0.001	1.113-54.519
0.73±0.04	0.84±0.03	2.20±0.26	1.47±0.26 (0.83-2.12)	<0.001	1.36±0.25 (0.74-1.98)	<0.001	0.106	<0.001	1.056-51.754
25.26±0.64	27.70±0.86	39.70±2.55	14.44±2.60 (7.99-20.89)	<0.001	12.00±2.63 (5.48-18.53)	0.001	0.084	<0.001	1.044-51.152
4.50±0.14	4.66±0.16	5.54±0.25	1.04±0.27 (0.38-1.70)	0.001	0.88±0.29 (0.15-1.61)	0.013	0.279	<0.001	1.162-56.958
27.56±0.30	28.62±0.33	30.18±0.77	2.62±0.86 (0.48-4.76)	0.012	1.56±0.84 (-0.52-3.64)	0.207	0.350	<0.001	1.212-59.386
			Individual Economic						
27.12±0.17	28.68±0.58	24.04±0.46	-3.08±0.40 (-4.06--2.10)	<0.001	-4.64 (-6.10--3.18)	<0.001	0.822	0.009	1.698 -83.191
2.00±0.00	2.04±0.03	7.46±0.59	5.46±0.59 (3.99-6.93)	<0.001	5.42±0.59 (3.96-6.89)	<0.001	0.007	<0.001	1.003-49.163
13.60±0.07	13.88±0.07	15.94±0.22	2.34±0.25 (1.71-2.97)	<0.001	2.06 (1.50-2.62)	<0.001	0.410	<0.001	1.258-61.643
15.26±0.40	15.56±0.38	15.72±0.34	0.46±0.25 (-0.17-1.09)	0.230	0.16±0.23 (-0.40-0.72)	1.00	0.512	<0.001	1.344-65.849
80.40±0.48	80.52±0.48	90.36±1.12	9.96±1.02 (7.44-12.48)	<0.001	9.84±0.93 (7.52-12.16)	<0.001	0.515	<0.001	1.347-66.012
			Food safety						
9.80±0.14	11.00±0.16	14.54±0.29	4.74±0.32 (3.94-5.54)	<0.001	3.54±0.32 (2.76-4.32)	<0.001	0.588	<0.001	1.417-69.411
28.06±0.31	29.58±0.30	28.40±0.46	0.34±0.54 (-0.99-1.67)	1.00	-1.18±0.56 (-2.58-0.22)	0.123	0.844	0.017	1.731-84.810
74.04±0.64	74.78±0.66	63.64±1.22	-10.40±1.44(-13.97--6.84)	<0.001	-11.14±1.50(-14.87--7.41)	<0.001	0.389	<0.001	1.241-60.818
4.62±0.10	4.74±0.10	6.14±0.15	1.52±0.19 (1.06-1.98)	<0.001	1.40±0.17 (0.97-1.83)	<0.001	0.865	0.031	1.762-86.331
36.08±0.54	37.20±0.53	40.20±0.58	4.12±0.79 (2.17-6.07)	<0.001	3.00±0.72 (1.21--4.79)	<0.001	0.665	<0.001	1.498-73.413
			Immune-boosting nutrients						
55.80±0.42	59.12±0.44	78.20±1.12	22.40±1.08 (19.71-25.09)	<0.001	19.08±1.07 (16.43-21.73)	<0.001	0.165	<0.001	1.090-53.413
8.38±0.08	9.58±0.09	17.10±0.70	8.72±0.71 (6.97-10.47)	<0.001	7.52±0.70 (5.78-9.26)	<0.001	0.029	<0.001	1.015-49.724
11.52±0.17	12.16±0.17	18.38±0.60	6.86±0.57 (5.46-8.26)	<0.001	6.22±0.54 (4.88-7.56)	<0.001	0.077	<0.001	1.040-50.951
12.92±0.11	13.32±0.10	19.26±0.37	6.34±0.38 (5.40-7.28)	<0.001	5.94±0.39 (4.98-6.90)	<0.001	0.290	<0.001	1.169-57.295
5.76±0.22	5.70±0.10	13.66±1.14	7.90±1.13 (5.10-10.70)	<0.001	7.96±1.13 (5.16-10.77)	<0.001	0.089	<0.001	1.047-51.291
			Starchy food						
27.12±0.13	27.66±0.18	34.80±0.61	7.68±0.67 (6.01-9.35)	<0.001	7.14±0.62 (5.60-8.68)	<0.001	0.223	<0.001	1.126-55.155
32.96±0.28	32.62±0.41	50.14±2.47	17.18±2.55 (10.87-23.49)	<0.001	17.52±2.51(11.29-23.75)	<0.001	0.097	<0.001	1.051-51.505
22.00±0.09	22.86±0.13	28.34±0.53	6.34±0.55 (4.98-7.70)	<0.001	5.48±0.56 (4.08-6.88)	<0.001	0.187	<0.001	1.103-54.044
36.96±0.54	36.90±0.53	46.06±1.23	9.10±1.33 (5.81-12.39)	<0.001	9.16±1.19 (6.20-12.12)	<0.001	0.388	<0.001	1.241-60.805
13.14±0.12	13.56±0.11	22.10±1.26	8.96±1.29 (5.76-12.16)	<0.001	8.54±1.28 (5.38-11.70)	<0.001	0.026	<0.001	1.013-49.647
			Meat						
14.44±0.22	14.72±0.24	17.06±0.22	2.62±0.34 (1.78-3.46)	<0.001	2.34±0.33 (1.51-3.17)	<0.001	0.795	<0.001	1.660-81.352
12.62±0.11	12.84±0.14	15.58±0.26	2.96±0.31 (2.19-3.73)	<0.001	2.74±0.28 (2.04-3.44)	<0.001	0.448	<0.001	1.288-63.126
50.34±0.33	51.72±0.36	62.10±1.10	11.76±1.17 (8.86-14.66)	<0.001	10.38±1.17 (7.48-13.28)	<0.001	0.137	<0.001	1.073-52.592

35.58±1.10	35.70±1.06	42.58±1.69	7.00±1.68 (2.84-11.16)	<0.001	6.88±1.13 (4.07-9.69)	<0.001	0.710	<0.001	1.550-75.926
52.42±0.28	53.08±0.59	61.18±0.70	8.76±0.72 (6.98-10.54)	<0.001	8.10±0.58 (6.67-9.53)	<0.001	0.939	0.223	

Milk and dairy products

66.44±0.20	67.12±0.39	78.70±1.03	12.26±1.06 (9.63-14.89)	<0.001	11.58±1.03 (9.04-14.12)	<0.001	0.433	<0.001	1.276-62.541
30.64±1.00	31.16±1.09	34.16±1.20	3.52±0.49 (2.30-4.74)	<0.001	3.00±0.39 (2.04-3.96)	<0.001	0.928	0.168	
16.16±0.18	16.54±0.15	20.04±0.53	3.88±0.45 (2.78-4.98)	<0.001	3.50±0.47 (2.34-4.66)	<0.001	0.147	<0.001	1.079-52.886
42.14±0.51	43.62±0.51	52.06±0.94	9.92±1.14 (7.09-12.75)	<0.001	8.44±0.94 (6.12-10.76)	<0.001	0.418	<0.001	1.264-61.939
21.88±0.28	22.14±0.28	28.46±0.73	6.58±0.82 (4.53-8.62)	<0.001	6.32±0.79 (4.36-8.28)	<0.001	0.119	<0.001	1.063-52.091

Vegetable and fruits

27.30±0.17	27.04±0.36	33.08±0.69	5.78±0.70 (4.04-7.52)	<0.001	6.04±0.76 (4.16-7.92)	<0.001	0.466	<0.001	1.304-63.906
57.30±0.26	58.98±0.38	70.70±1.55	13.40±1.57 (9.52-17.28)	<0.001	11.72±1.57 (7.83-15.62)	<0.001	0.171	<0.001	1.094-53.584
18.92±0.28	19.84±0.35	24.58±0.40	5.66±0.39 (4.70-6.63)	<0.001	4.96±0.37 (4.05-5.87)	<0.001	0.626	<0.001	1.456-65.525
15.64±0.12	15.76±0.14	18.94±0.35	3.30±0.34 (2.45-4.15)	<0.001	3.18±0.39 (2.23-4.14)	<0.001	0.342	<0.001	1.206-59.105
10.38±0.21	11.06±0.24	13.60±0.38	3.22±0.37 (2.29-4.15)	<0.001	2.54±0.37 (1.63-3.45)	<0.001	0.259	<0.001	1.149-56.303

Cooking-oil

71.18±0.42	72.08±0.40	82.32±1.12	11.14±1.32 (7.86-14.42)	<0.001	10.24±1.28 (7.08-13.40)	<0.001	0.235	<0.001	1.133-55.522
67.46±1.03	57.86±0.64	63.02±1.22	-4.44±1.44 (-8.00--0.88)	0.010	5.16±1.34 (1.84-8.48)	0.001	0.603	<0.001	1.432-70.152
11.90±0.52	12.54±0.18	11.40±0.23	-0.50±0.56 (-1.88-0.88)	1.00	-1.14±0.27 (-1.80--0.48)	<0.001	0.463	<0.001	1.302-63.775
9.86±0.22	9.98±0.20	12.34±0.36	2.48±0.37 (1.56-3.40)	<0.001	2.36±0.35 (1.50-3.22)	<0.001	0.514	<0.001	1.346-65.947
2.14±0.05	2.20±0.06	3.14±0.07	1.00±0.09 (0.79-1.21)	<0.001	0.94±0.08 (0.75-1.13)	<0.001	0.982	0.649	

Canned food products

3.68±0.19	4.00±0.22	4.80±0.20	1.12±0.25 (0.51-1.73)	<0.001	0.80±0.22 (0.26-1.34)	<0.001	0.775	0.002	1.633-80.009
1.48±0.07	1.74±0.06	2.24±0.09	0.76±0.12 (0.46-1.07)	<0.001	0.50±0.10 (0.24-0.76)	<0.001	0.865	0.031	1.763-86.373
16.36±0.19	17.14±0.24	21.68±0.77	5.32±0.73 (3.51-7.13)	<0.001	4.54±0.82 (2.51-6.57)	<0.001	0.358	<0.001	1.218-59.689
18.12±0.78	19.66±0.84	26.82±1.06	8.70±0.80 (6.71-10.69)	<0.001	7.16±0.82 (5.12-9.20)	<0.001	0.362	<0.001	1.221-59.818
38.94±1.40	39.02±0.81	44.06±1.16	5.12±1.23 (2.07-8.17)	<0.001	5.04±0.94 (2.71-7.38)	<0.001	0.829	0.011	1.708-83.672

Sugary foods

60.72±0.31	58.46±0.31	72.74±1.56	12.02±1.64 (7.96-16.08)	<0.001	14.28±1.51(10.54-18.02)	<0.001	0.167	<0.001	1.091-53.456
15.28±0.75	15.48±0.67	19.80±0.77	4.52±0.69 (2.82-6.22)	<0.001	4.32±0.65 (2.72-5.93)	<0.001	0.130	<0.001	1.069-52.404
30.54±0.81	30.22±0.69	35.96±0.97	5.42±0.95 (3.07-7.77)	<0.001	5.74±0.77 (3.83-7.65)	<0.001	0.324	<0.001	1.194-58.486
10.46±0.33	10.38±0.22	14.24±0.60	3.78±0.68 (2.10-5.46)	<0.001	3.86±0.64 (2.28-5.44)	<0.001	0.596	<0.001	1.425-69.824
4.94±0.04	4.80±0.06	6.24±0.22	1.30±0.22 (0.76-1.84)	<0.001	1.44±0.20 (0.94-1.94)	<0.001	0.187	<0.001	1.103-54.055

Alcoholic beverages

63.56±0.38	64.22±0.58	49.40±1.61	-14.16±1.62(-18.17--10.15)	<0.001	-14.82±1.80(-19.27--10.37)	<0.001	0.206	<0.001	1.115-54.635
58.28±0.73	55.92±0.97	40.86±1.91	-17.42±2.08(-22.57--12.27)	<0.001	-15.06±2.14(-20.36--9.76)	<0.001	0.109	<0.001	1.058-51.837
32.10±0.35	31.32±0.42	30.66±0.35	-1.44±0.26 (-2.08--0.80)	<0.001	-0.66±0.29 (-1.38-0.06)	0.081	0.869	0.035	
37.68±0.47	37.46±0.56	39.42±0.50	1.74±0.43 (0.69-2.79)	<0.001	1.96±0.34 (1.11-2.81)	<0.001	0.864	0.030	1.761-86.299
11.34±0.22	12.16±0.23	14.14±0.38	2.80±0.40 (1.82-3.78)	<0.001	1.98±0.37 (1.07-2.89)	<0.001	0.372	<0.001	1.229-60.205

Food types

49.40±1.61	47.30±0.43	56.36±1.45	6.96±2.76 (0.11-13.81)	0.045	9.06±1.49 (5.36-12.76)	<0.001	0.342	<0.001	1.206-59.902

40.86±1.91	25.36±0.41	30.96±0.78	-9.90±2.24 (-15.44-4.36)	<0.001	5.60±0.90 (3.38-7.82)	<0.001	0.378	<0.001	1.233-60.436
30.66±0.35	43.26±0.62	61.90±1.32	31.24±1.19 (28.29-34.20)	<0.001	18.64±1.62 (14.61-22.67)	<0.001	0.434	<0.001	1.277-62.591
39.42±0.50	11.86±0.23	16.36±0.57	-23.06±0.92(-25.35--20.77)	<0.001	4.50±0.62 (2.97-6.03)	<0.001	0.616	<0.001	1.445-70.785
14.14±0.38	30.68±0.39	31.66±0.44	17.52±0.68 (15.84-19.20)	<0.001	0.98±0.45 (-0.14-2.10)	0.103	0.790	0.004	1.653-81.007

Food sourcing

66.36±0.94	69.34±0.79	70.26±1.58	3.90±1.59 (-0.38-7.84)	0.053	0.92±1.49 (-2.77-4.61)	1.00	0.800	0.005	1.666-81.636
15.28±0.75	15.48±0.67	19.80±0.77	4.52±0.69 (2.82-6.22)	<0.001	4.32±0.65 (2.72-5.93)	<0.001	0.130	<0.001	1.069-52.404
8.78±0.21	9.08±0.25	14.70±0.82	5.92±0.80 (3.94-7.90)	<0.001	5.62±0.81 (3.60-7.64)	<0.001	0.370	<0.001	1.227-60.134
14.78±0.38	14.32±0.41	20.82±1.30	6.04±1.19 (3.10-8.98)	<0.001	6.50±1.19 (3.55-9.45)	<0.001	0.440	<0.001	1.282-62.827
3.48±0.14	3.84±0.14	6.72±0.54	3.24±0.53 (1.92-4.56)	<0.001	2.88±0.54 (1.55-4.21)	<0.001	0.335	<0.001	1.201-58.866

Social factors

42.60±0.46	44.16±0.46	34.36±1.29	-8.24±1.22 (-11.28--5.21)	<0.001	-9.80±1.25 (-12.89--6.71)	<0.001	0.118	<0.001	1.063-52.083
5.78±0.07	6.04±0.03	9.04±0.45	3.26±0.47 (2.11-4.41)	<0.001	3.00±0.45 (1.89-4.12)	<0.001	0.052	<0.001	1.027-50.303
1.00±0.00	1.00±0.00	2.28±0.14	1.28±0.14 (0.93-1.63)	<0.001	1.28±0.14 (0.93-1.63)	<0.001	0.000	-	1.000-49.000
48.50±0.56	47.18±0.56	61.72±1.97	13.22±2.20 (7.78-18.66)	<0.001	14.54±2.10 (9.33-19.75)	<0.001	0.200	<0.001	1.111-54.452
9.52±0.15	9.60±0.14	11.54±0.27	2.02±0.31 (1.25-2.79)	<0.001	1.94±0.24 (1.35-2.53)	<0.001	0.728	<0.001	1.573-77.064

Individual factors

38.56±0.62	36.40±0.48	39.24±0.79	0.68±0.73 (-1.12-2.48)	1.00	2.84±0.67 (1.18-4.50)	0.001	0.336	<0.001	1.202-58.908
67.56±1.01	69.06±0.94	81.22±1.63	13.66±1.49 (9.96-17.36)	<0.001	12.16±1.58 (8.24-16.08)	<0.001	0.169	<0.001	1.092-53.324
6.76±0.07	6.84±0.07	7.16±0.11	0.40±0.11 (0.14-0.67)	0.001	0.32±0.12 (0.05-0.59)	0.015	0.470	<0.001	1.307-64.051
5.32±0.07	5.22±0.07	7.00±0.20	1.68±0.21 (1.16-2.20)	<0.001	1.78±0.23 (1.21-2.35)	<0.001	0.169	<0.001	1.092-53.515
58.66±0.25	59.46±0.25	67.82±0.72	9.16±0.79 (7.20-11.12)	<0.001	8.36±0.69 (6.65-10.07)	<0.001	0.229	<0.001	1.129-55.324

Food purchasing

6.94±0.09	7.74±0.09	11.12±0.59	4.18±0.62 (2.65-5.71)	<0.001	3.38±0.61 (1.87-4.89)	<0.001	0.044	<0.001	1.023-50.113
9.08±0.14	9.76±0.25	11.06±0.36	1.98±0.37 (1.06-2.90)	<0.001	1.30±0.46 (0.17-2.43)	0.019	0.280	<0.001	1.163-56.991
45.46±0.36	40.82±1.09	54.44±0.76	8.98±0.96 (6.61-11.35)	<0.001	13.62±1.30 (10.40-16.84)	<0.001	0.885	<0.01	1.794-87.905
53.64±0.87	54.90±0.97	38.34±1.37	-15.30±1.62(-19.31--11.29)	<0.001	-16.56±1.77(-20.95--12.17)	<0.001	0.520	<0.001	1.351-66.223
16.14±0.20	15.32±0.17	19.28±0.46	3.14±0.50 (1.89-4.39)	<0.001	3.96±0.54 (2.62-5.30)	<0.001	0.262	<0.001	1.151-56.397

Physical activities

62.86±0.60	62.68±0.61	67.64±1.01	4.78±0.80 (2.79-6.77)	<0.001	4.96±0.82 (2.92-7.00)	<0.001	0.667	<0.001	1.500-73.504
45.58±0.51	46.50±0.55	51.82±0.74	6.24±0.48 (5.05-7.44)	<0.001	5.32±0.44 (4.23-6.41)	<0.001	0.828	<0.001	1.707-83.642
67.36±0.53	69.52±0.58	64.08±1.36	-3.28±1.15 (-6.12--0.44)	0.019	-5.44±1.10 (-8.18--2.70)	<0.001	0.312	<0.001	1.185-58.045
25.44±4.68	25.72±5.10	28.96±6.78	3.52±0.71 (1.76-5.28)	<0.001	3.24±0.68 (1.55-4.93)	<0.001	0.322	<0.001	1.192-58.389
60.84±2.08	60.58±2.07	50.12±1.88	-10.72±1.26(-13.85--13.45)	<0.001	-10.46±1.21 (-13.45--7.47)	<0.001	0.388	<0.001	1.241-60.808

Sports equipment

66.06±0.81	64.18±1.27	62.86±1.56	-3.20±1.15 (-6.05--0.36)	0.023	-1.32±2.10 (-6.52-3.88)	1.00	0.465	<0.001	1.303-63.808
4.94±0.06	5.08±0.07	9.20±0.45	4.26±0.45 (3.14-5.37)	<0.001	4.12±0.46 (2.97-5.27)	<0.001	0.076	<0.001	1.040-50.948
28.02±0.51	29.32±0.57	47.44±1.36	19.42±1.58 (15.49-23.35)	<0.001	18.12±1.65 (14.04-22.20)	<0.001	0.038	<0.01	1.020-49.960

12.82±0.26	13.38±0.28	27.50±1.23	14.68±1.32 (11.40-17.96)	<0.001	14.12±1.35 (10.78-17.46)	<0.001	0.028	<0.001	1.007-49.688
27.02±0.23	28.38±0.23	52.28±2.48	25.26±2.51 (19.04-31.49)	<0.001	23.90±2.56 (17.57-30.23)	<0.001	0.016	<0.001	1.008-49.406
Leisure activities									
18.40±0.26	18.28±0.35	6.64±0.66	-11.76±0.65(-13.37--10.15)	<0.001	-11.64±0.75 (-13.50--9.78)	<0.001	0.371	<0.001	1.228-60.154
12.52±0.16	12.82±0.16	6.16±0.40	-6.36±0.51 (-7.63--5.09)	<0.001	-6.66±0.49 (-7.88--5.44)	<0.001	0.119	<0.001	1.063-52.087
36.04±0.27	32.40±0.27	40.38±1.12	4.34±1.14 (1.53-7.16)	0.001	7.98±1.13 (5.19-10.77)	<0.001	0.198	<0.001	1.110-54.370
65.46±0.69	67.74±0.65	69.60±0.64	4.14±0.62 (2.60-5.68)	<0.001	4.86±0.54 (3.53-6.19)	<0.001	0.688	<0.001	1.525-74.701
93.68±0.28	89.12±0.48	88.70±0.52	-4.98±0.63 (-6.53--3.43)	<0.001	-0.42±0.74 (-2.24-1.40)	1.00	0.873	<0.001	1.775-86.956
Psychological factors									
17.76±0.14	18.30±0.13	20.62±0.28	2.86±0.33 (2.05-3.67)	<0.001	2.32±0.31 (1.56-3.08)	<0.001	0.142	<0.001	1.230-60.275
70.14±0.50	71.86±0.54	68.38±0.74	-1.76±0.88 (-3.95-0.43)	0.156	-3.48±0.94 (-5.80--1.16)	0.002	0.518	<0.001	1.350-66.145
9.42±0.16	10.22±0.16	20.94±1.98	11.52±1.94 (6.71-16.33)	<0.001	10.72±1.97 (5.84-15.60)	<0.001	0.013	<0.001	1.006-49.318
15.22±0.13	14.20±0.13	18.02±0.80	2.80±0.02 (0.92-4.68)	0.002	3.82±0.84 (1.73-5.91)	<0.001	0.120	<0.001	1.064-52.121
78.26±0.67	82.84±0.54	92.98±0.50	14.72±0.78 (12.78-16.66)	<0.001	10.14±0.70 (8.41-11.87)	<0.001	0.821	0.009	1.696-83.117

A Community-supported agriculture; df Degree of Freedom; RSV Relative Search Volumes; S. bicycle Stationary bicycle; SE Standard Error

Figure 8. Bar graph comparing the percentage differences of RSVs Eating Behavior and Its Related Factors before- (Average mean of RSVs in 2018 and 2019) and during-COVID-19 pandemic (Mean of RSVs in 2020). Examined period: January 1 to December 13 each year

4. Discussion

The COVID-19 pandemic has affected and led to a great loss of billions of people worldwide and presents serious unprecedented challenges to human eating behavior. Basically, individual eating behavior is a complex issue that is influenced by a variety of personal, social, cultural, environmental, and economic factors [24]. Our results revealed that during the COVID-19 pandemic, people worldwide were faced with immediate far-reaching effects on numerous related factors that develop to eating behavior. A recent study held by the International Food Information Council showed that 85% of consumers said they were doing something differently [27]. These effects were more likely to occur during the beginning period of the lockdown, however, if these restricted measures are extended, consequences will be prolonged which can trigger the domino effect, and therefore substantial impact on eating behavior, which can turn to new eating habits in the long-term period. All these changes may relatively contribute to the development of obesity and non-communicable diseases, that correlated with chronic inflammation and further lead to serve complications of COVID-19 [28].

Negatively, COVID-19 lockdown has directly impacted the food supply chain, food security, and individual income, which are strongly linked to food choices and preferences [29]. Due to the pandemic, governments around the world have made significant restrictions on foodstuff movement and transportation. It was noticed that the labor shortage crisis has appeared during the COVID-19 confinement, caused harsh interruptions in many food-related sectors like horticulture, planting, sorting, harvesting, crop processing, and livestock production [30]. For instance, many skilled workers in the harvest could not access due to border controls, whereas meat-processing production was heavily suspended in numerous plants due to the COVID-19 positive-cases among workers were found, as well as those who were reluctant to go to work, afraid that they would get sick at work. During April 2020, it has been forecasted that the production capacity of US pork facilities decreased by one fourth [8]. In addition, the distribution of food products was also delayed during the lockdown, which increased the pressure and reliance on domestic production, created shortages, and food insecurity in deficit areas [31]. Previous reports showed that the truck services for food distribution in France were reduced to 60% and were declined by 30% comparing with pre-pandemic during the closure period. [32]. This disruption has led consumers to experience reduced availability and somehow the shortage of certain food types during COVID-19 lockdown, which risen the fear of food insecurity and food shortage around the world [12]. This real concern was agreed with an increase of online interest in "food security", "food bank" and "free food", which were found in the present study. Apparently, a study conducted among 3219 US respondents showed that 32.3% of household food were insecure since COVID-19, with 35.5% were classified as newly food insecure [7]. The study also indicated that people experiencing a job loss were at higher odds of experiencing food insecurity with an odds ratio of 3.06 [7]. Hence, there were potential and relevant impacts between food insecurity and individual economic. In the same context, COVID-19 has also boosted the unemployment rate globally, which has resulted in millions of people losing access to employment. The national unemployment rate in the US during COVID-19 has rivaled that of the Great Depression with more than 30 million adults have filed for unemployment benefits [33]. This scenario is strongly conceded with our results, which explained that people globe paid more attention to the search for mitigation programs for "unemployment", how to earn "money" during the lockdown. In the meantime, keenness in searching for "jobs", and querying "price" for good purchasing was dramatically declined.

Other factors involved in consumers' food choices and preferences establishment, it is recognized that these concerns also diverge depending on the food's price, local consumption background, shopping preferences, consumer's income, and time constraints [32]. To some extent, the number of visits to the grocery, food shop, or supermarket and how much money was spent on food per visit were serve as indicators. A recent study investigated during the quarantine period in France, it was shown that over 50% of shoppers changed their views on the social, economic, and ecological value of foodstuffs. The results

further emphasized that 32% of French consumers would only buy "necessary' foods", 51% willing to support improving the availability of "local foods", and 29% pay more attention to the prices even during the post-COVID-19 lockdown [34]. In times of economic recession parallel with COVID-19 pandemic, in contrast to the pre-pandemic behavior and preferences, consumer reduced visiting "shopping mall", preferences has gone for "grocery store", "super-market" to buy the necessary local merchandises, "local meat", "local fruits" and "local foodstuff" with budget-friendly and long-life products rather than imported food items [35]. These new food purchasing behaviors were strongly agreed with this study's results.

Doubtlessly, our results and previous reports affirmed that COVID-19 quarantine interrupted the routine activities and rapidly resulted in "isolation" and "boredom", which can lead to high energy intake by the increasing consumption of the high amount of energy, carbohydrate, fat, and protein and reduced consumption of rich-nutrient foodstuff such as vegetable or fruit [28]. Precisely, quarantine caused "stress", "anxiety" and "insomnia" [36], and pushed people to increasingly consume "sugary foods" for comfort eating and feeling positive due to its ability to encourage brain serotonin production [37]. For instance, 47% of US consumers said that they consumed more sweets, 24% consumed fewer vegetables, 21% consumed less fruit, and 19% consumed less protein [38]. Consistently, other studies in Italy and France determined that 44.5% of Italian had more sweet consumption and 16% of them drank more wine [13], whereas, 42% of French adults declared having pre-meal drinks ("apéritif") more often than before during the lockdown, as well as increased consumption of sweets, biscuits, and cakes [39]. Albeit criticalities due to processing procedures and their nutritional value (often high amount in salt, sugar, and saturated fats), these packed products have confirmed to be necessary in comply with food requirements during the emergency situation (e.g. natural disaster or pandemic), but it should be applied in the short-term period [40]. With all the above explanations, these observations adequately supported our current results in terms of increase global searches in "comfort food" particularly, "cake", "chocolate", "cookie", "pancake" and "tart".

Furthermore, the risks of staying at home during quarantine, including a rise in alcohol use, could also lead to an increase of NCDs to which excessive alcohol consumption is one of the risk factors. A unique example was found in Iran, where the encounter of a long-time held ban on alcohol along with falsification regarding the anti-virus benefits of consuming alcohol has resulted in more than 700 cases of methanol poisoning [41]. In our study, similar surveillance was reported with the increase of worldwide interest in "wine" and "liquor". In the meantime, searches for "beer" were less likely to increase since it is the most appropriate drink for relaxation-oriented with friends, rather than for stress-reducing purposes. Notably, the demand for alcoholic beverages did not surge within the first week. However, it was more likely to increase about twice during one month after the pandemic announcement.

On the brighter side, COVID-19 has some positive impacts on home-cooking, food safety, and food demand. At first, because of the restrictions, consumers limited their traveling to the public area for food purchasing such as markets or supermarkets due to afraid of catching the COVID-19. They therefore alternatively preferred using "take-out", "online-shopping", and food-home "delivery" option via online-system [32,42]. For instance, during the COVID-19 outbreak, 20% of French consumers were more likely to lessen their frequency of food shopping and replaced it with online shopping [34], whereas the figures reported among US consumers were 70% [38]. Besides, the closure of restaurants and limited-service eating places affected the eating habits and increased "meal-cooking" preparation at home with searching for "recipe". Reports during the lockdown period emphasized the food purchasing from retail services as well as using food services has downed half compared with pre-outbreak [32]. A study conducted in 7,753 US participants reported that during the pandemic, the overall scores for healthy eating increased as a result of less eating out and increased home-cooking [43]. Similar findings were found in Chinese participants, which mentioned that 61.6% of participants had recently decreased eating in restaurants, while 64.8% of responses reported increased cooking at home [44]. Relevant figures were found in Lithuania with 62.1% of responses

cooked at home more often [45]. These new normal phenomena were aligned with our current results in social factors with home-cooking and food-delivery services issues.

Next, we examined how food safety was concerned during the pandemic. Previous surveys have affirmed that COVID-19 has undeniably raised people's awareness about "sanitation", hygiene, cleaning, and disinfection practices. The present outcomes revealed that people worldwide were less likely to query for "food safety" and "food poisoning" symptoms during the lockdown. Alternatively, the high demand for "food storage containers" and "food packaging" was observed during the quarantine. The fact that when asking about which activities that people dramatically change before the pandemic, a majority of respondents reported an increased frequency of hand hygiene, cleaning in the home, and disinfection of high-touch surfaces, sanitary recommendations (e.g. washing hands, separating raw and cooked meat) [46]. Moreover, recent Spanish epidemiological surveillance showed a decrease in the reported number of food-borne infections [47]. The fact that most consumers surveyed have high confidence in the safety of the food system (67%), However, the top concerns have been shifted from foodborne illness or chemicals contamination to microbial contamination from food handling or preparation in light of the pandemic [27].

Thirdly, the COVID-19 pandemic was more likely to increase the food demand, vitamin supplementations to boost the body immune system, and sports equipment. The fact that COVID-19 has created uncertainty about the future among consumers, that may lead to massive changes in their purchasing behaviors [48]. Our results showed that some purchasing behaviors will probably return to their previous state (e.g., egg, milk, cheese, vegetables and fruits, sugar foods), whilst some may not, as newly acquire behaviors are easier, cheaper, and more long-lasting than previous (e.g., staple starchy food, chicken, fish, olive oil, canned foods, dried foods, frozen foods, vitamin supplements, and sports equipment). Previous studies observed that the frequency of visits to food purchasing during quarantine was reduced while money spent was relatively increased per visit [32]. These changes of online interests in foodstuff may come from (1) the increased demand for home-cooking [48], (2) indulge in comfort eating; (3) uncertain about the ending of the outbreak that leads to stocking up and panic buying, and (4) awareness about healthier eating by making a plan for eating and drink healthier [49]. The previous study in European countries explored that, bread, flour, and butter received more attention from consumers, and sometimes unavailable on shelves due to the keenness in family home-baking activity during confinement [32,42]. A similar observation was reported in the US population with 56% of responses are worried about not finding some particular food products they need or forgetting to buy something [38]. As a result, Crisp has forecasted that the demand for fresh bread gained by 76% and frozen vegetables and fruits by 52% in the week when the pandemic was announced [50]. Due to limited outdoor activities, consumers were more likely to purchase and store the products with long-shelf-life due to convenience and daily cooking at home [48]. For instance, In Italy, canned food such as canned pasta, meat, and fish, were among the most purchased items, all showing the growth of 226%, 200% and 164% respectively. In UK, Tesco also revealed that during the lockdown period, the sales of canned tomato raised double times with about 3.3 million tins sold across the country [51]. The history showed that household egg consumption was increased 40% since March 20 in Argentina and sales of eggs rose by 44% compared to last year in the US. Moreover, US consumers were more likely to shift to long-durable products such as packet soups, canned vegetables, and Ultra-High Temperature processing pasteurized milk [52]. Similar with previous marketing reports, the present results revealed the similar phenomena in online interest with the searches were different based on the local cuisine and food context.

Regarding healthier eating behavior, in a recent nationwide poll in the Italian population during COVID-19 quarantine, the study revealed that healthy food and beverage consumption increased for vegetables (33%), fruit (29%), legumes (26.5%), and extra virgin olive oil (21.5%) [47]. In the Western hemispheres, 43% of US consumers emphasized that they consume more fruits, 42% more vegetables, and 30% more protein-containing foods (meat, chicken, or fish). Besides, 39% of consumers stated that they

made their breakfast more filling and balanced [38]. Furthermore, in a study on 18 countries around the globe by FMCG Gurus, it was shown that the purchasing behavior of the consumers has changed because of their will to consume healthy foods (73%). Especially, the top three healthier steps were to increase the intake of fruit (58%), reduce sugar intake (45%), and increase protein intake (37%) [53]. However, at a similar time, customers also mentioned the financial issues to achieve this plan without exceeding the normal budget [53].

As our body immune-system is the "first-responder" to react immediately to signs of viruses or bacteria. Our results revealed that during the whole year presence of the COVID-19 pandemic, people worldwide paid more concerns to maintain their health by looking for "immunity" as well as search for "immune-boosting nutrients" such as "vitamin C", "vitamin D", "zinc" as well as "vitamin" in general. Indeed, a survey from FMCG Gurus showed that 59% of responses paid more conscious about their overall health, therein 57% worry about their immunity [53]. The ingredients that consumers consider healthiest are fiber, whole grains and plant proteins with the proportion were all above 70% [27]. Consequently, consumers were more likely to prefer a basic approach of returning to natural products that contain immune-boosting ingredients such as fruits and vegetables, legumes, whole grains, or olive and coconut oil. Meanwhile, most consumers are worried about the effect of COVID-19 on their mental wellness, therefore, they tended to look for food products to improve mood such as "fish" with expecting of adding "omega-3" into their diet [53]. The turning to daily natural products will be linked to trust and affordability, which is crucial at a time when 63% of consumers believe that the global world recession is currently moved into [53].

Not only influences on food choices and preferences, but COVID-19 has also raised awareness related to weight or further to "obesity" concerns, which is strongly associated with mortality of COVID-19 [54]. Our results reported the increase of "weight loss" concern as well as keenness on private-sport activities (e.g. running, walking, cycling) and equipment (yoga-mat, treadmill, stationary bike, dumbbell) during the lockdown period as well as during the COVID-19 pandemic. A previous Italian cross-sectional study indicated that 46.1% of consumers said that they consumed more food during the quarantine, and 19.5% witnessed their weight gain [55]. Similar findings from a US survey explored that 22% of the sample stated they gained 5-10 pounds [56]. Among those who gained 5-10 pounds, there was a significantly higher percentage of the total sample who reported they increased eating in response to sight and smell, eating in response to stress, and snacking after dinner compared to those who stated they did not change those behaviors at all [56]. Another finding from the Kuwaiti public reported that those with unhealthy diets were 4.5 times more likely to report an increase in weight [57].

At some point, the immediate consequences of COVID-19 will abate. Social distancing rules will relax, people will return to a new normal life. However, there are likely to be long-term impacts and concerns felt in the human life global in negative influences. Most consumers believe that COVID-19 will continue to influence day-to-day lives for at least in the next twelve months [53]. The detrimental psychological challenges of the COVID-19 pandemic are more likely to extend until the outbreak's end. Our study showed that such feeling as "anxiety" and social "isolation" tended to continuously appear with high volumes throughout the year, and predict to keep remaining in the future period. These results agreed with the previous study that explored that stress, feeling of emptiness, and boredom associated with eating was common behaviors in the French population during the lockdown [58]. In a recent survey administered during the Covid-19 pandemic indicated that children, students, and young adults were particularly at risk of developing anxious symptoms [59,60], who more likely to experiencing stress, anxiety, and depression than others during the pandemic [61].

The fact that the COVID-19 pandemic has thrust the world into a crisis, especially during the global shutdown period. Although the disease and its consequences have impacted people in varying degrees, it has produced some common experiences. From our present study, the impacts of the COVID-19 lockdown

measures can be divided into short- and long-term effects, which depend on the issues' necessity and characteristics. Our results revealed that the immediate impacts of COVID-19 confinement measures on people worldwide concern were more likely to appear within the first closure month. People tend to adapt to the new environment and condition and can gradually be returned to the pre-pandemic stage. During the global shutdown, consumers around the globe expressed their deep concerns about the scarcity of food resources, individual incomes cutting down, which led to budget-saving behavior. These new adaptations have associated to reduce the interest for "shopping mall". Consumers preferable sought for "grocery store" or "supermarket" for purchasing the necessary and budget-friendly merchandisers. In addition, these shocks have led to stocking up and panic buying, especially in all types of "staple", "healthy", "local", and "natural" food and drink products and types, as well as "long shelf-life" foodstuff. Moreover, the high demand for food storage containers, food packaging, and comfort foods (i.e. sugary foods) was observed. As the scare of diseases, people worldwide paid more keenness on "sanitation", resulted in dramatically reducing searches for "food-poisoning". At the same time, they are highly concerned about improving their body immune system and health, by watching their "bodyweight" and "calories" intake along with the increase of private physical activities (e.g. running, walking, cycling). However, the COVID-19 pandemic also creates a stressful atmosphere for habitants around the world with increasing interest in alcoholic beverages (i.e. wine and liquor) for stress relief, as well as growing concerns for some psychological symptoms such as insomnia, isolation, anxiety, or boredom.

This is the first study investigating the impacts of the COVID-19 pandemic on global eating behavior by using Google Trend-Relative Search Volumes. Several limitations in the present study should be acknowledged. First, the use of English keywords and Google as the search engine may not accurately and directly reflect the true global interests. Second, Google Trend's RSVs data were only relative volumes and not absolute values. Lastly, the present study was also limited by its retrospective nature. Therefore, further surveillance is needed to confirm the changes in eating behaviors as well as related nutrition-health outcomes. Nevertheless, the strengths of the study can be conceded as the use of worldwide Google Trend's RSVs data with popular and comprehensive search terms might overview the global in general and local eating behavior in specific. The strong correlation of surveyed keywords in "eating behavior" with "COVID-19 daily confirmed cases", "COVID-19 cumulative cases", and "coronavirus RSV", suggesting similar predictive effects of real concern.

5. Conclusions

COVID-19 has dramatically made the accessibility to and availability of food more challenging for many worldwide, an undesirable situation that is likely to remain for the foreseeable future as an aftershock of the pandemic. Throughout the year with the COVID-19 pandemic, despite no major issues that have been observed in the food supply chains worldwide so far, however, it remains unclear in the face of an uncertain future. As eating and purchasing behavior plays a key role in the food security and food supply chain, the COVID-19 outbreak has far-reaching both direct and indirect effects on human eating behavior and its related factors. These new behavior types will continue once the restrictions have been lifted, albeit to a lesser extent. During the lockdown, the COVID-19 pandemic has caused a significant rise in foodstuff demand in all kinds, accompanied by stocking up and panic buying, changing food purchasing behavior and healthier dietary habits in favor of local, natural, long-life products, immune-boosting ingredients, altering the social distancing lifestyle habits with sought on private-sport equipment and delivery services. Notably, the pandemic also brought dramatic pessimism for human mental wellness. Therefore, understanding the COVID-19 impact behind restriction policies is crucial to provide any swift and flexible actions to strengthen the resilience of the food supply chain and food system, support and adapt to the new

normal behavior, and mitigation the profound negative changes, especially targeting those in high-risks and vulnerable groups and food-insecure regions.

Supplementary Materials: Table S1: Checklist for Documentation of Google Trends research. Modified from Nuti et al.

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Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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